

**Profiling work health and safety incidents and injuries in Australian army personnel: An investigation of injuries and other incidents suffered by army reserve personnel**

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October 2016

# Profiling work health and safety incidents and injuries in Australian army personnel: An investigation of injuries and other incidents suffered by army reserve personnel

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# PROFILING WORK HEALTH AND SAFETY INCIDENTS AND INJURIES IN AUSTRALIAN ARMY PERSONNEL



AN INVESTIGATION OF INJURIES AND OTHER  
INCIDENTS SUFFERED BY ARMY RESERVE  
PERSONNEL



**BOND  
UNIVERSITY**  
TACTICAL RESEARCH UNIT

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## TACTICAL RESEARCH UNIT TEAM

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### Project Lead: Assistant Professor Robin Marc Orr



Dr Rob Orr joined the Australian Army in 1989 as an infantry soldier before transferring to the Defence Force Physical Training Instructor (PTI) stream. Serving for 10 years in this stream, Rob designed, developed, instructed and audited physical training programs and physical education courses for military personnel and fellow PTIs from both Australian and foreign defence forces. Rob subsequently transferred to the physiotherapy stream where his role included the clinical rehabilitation of defence members and project management of physical conditioning optimisation reviews. Serving as the Human Performance Officer for Special Operations before joining the team at Bond University in 2011, Rob continues to serve in the Army Reserve as a Human Performance Officer and as a sessional lecturer and consultant. With Dr Rodney Pope, Rob is co-lead of the newly formed Bond University Tactical Research Unit, a unit with international collaborations designed to provide research, consultancy and education services to tactical professions. Rob is also the co-chair of Tactical Strength and Conditioning (TSAC) – Australia.

Rob's fields of research, consultancy and education provision spans physical conditioning and injury prevention for military and protective services across their occupational lifespan (initial trainee to specialist). Generally focussing on the tactical population, Rob is actively involved in research with the Australian and foreign defence forces, several law enforcement departments (both national and international), and firefighters / first responders.

### Project Lead: Associate Professor Rod Pope



Dr Rod Pope is currently Associate Professor of Physiotherapy at Bond University. Rod provided clinical physiotherapy, rehabilitation and injury prevention services at the Australian Army Recruit Training Centre 1990-2000 before establishing and leading the Australian Defence Injury Prevention Program 2000-2006, at the request of the Defence Health Services Branch. In this role he worked closely with military health and safety staff and commanders, and with senior military Physical Training Instructors to implement systems to monitor and mitigate risks of injury in military personnel and to optimise physical training practices and physical performance.

As part of this work and more recently in his subsequent University roles, Rod has conducted and supervised wide-ranging research and consultancy projects on preventing injuries and enhancing performance in wide-ranging tactical training and operational contexts. In recent years, he has supervised to successful completion the doctoral-level tactical research of two Army officers and one Defence civilian, and with Dr Rob Orr he is currently supervising the tactical research of two police officers as they each undertake higher degrees by research.

**Research Officer: Assistant Professor Ben Schram**



Dr Ben Schram is an Assistant Professor at Bond University in the Doctor of Physiotherapy program along with working clinically in a variety of private practices. He has extensive experience in both exercise science and strength and conditioning and has recently completed a PhD at Bond University.

Ben has previously experienced Officer Training with the Australian Army Reserves providing further insight into the demands of Army training. He has subsequently been extensively involved with Tactical Research Unit research projects with both the military and federal police.

**Student Researcher: Dylan MacDonald**



Dylan MacDonald has recently graduated from the Doctor of Physiotherapy program at Bond University having undertaken his research project with the Tactical Research Unit as part of his internship. Dylan completed a Bachelor of Science in Kinesiology at the University of Calgary prior to his Doctor of Physiotherapy studies.

## Academic Reviewer: Professor Wayne Hing



Dr Wayne Hing has enjoyed a distinguished career in the field of musculoskeletal physiotherapy. He has a PhD in Anatomy, as well as a Master of Science in Physiology (both from the University of Auckland) along with postgraduate qualifications in Orthopaedic Manipulative Therapy and acupuncture.

Following holding an academic position at Auckland University of Technology and UNITEC, Bond University's Faculty of Health Sciences and Medicine welcomed Dr Hing as their Professor in Physiotherapy and Head of the Physiotherapy from May 2012.

Since 1994, Dr Wayne Hing has been a leading consultant, advisor and reviewer for various committees, boards and working parties related to New Zealand physiotherapy such as the New Zealand Manipulative Physiotherapists Association (NZMPA), Society of Physiotherapists (NZSP), Hockey New Zealand and the Health and Disabilities Commission.

In terms of research, Dr Hing has received funding for over 40 projects including a major grant of \$237,000 for a three-year study into the diagnostic accuracy of a clinical examination in determining the source of shoulder pain from the Health Research Council of New Zealand for one of his PhD students. The results from his research have been published extensively in international peer-reviewed journals and he is regularly invited to deliver conference presentations at national and international symposiums.

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## EXECUTIVE SUMMARY

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The Army reserve soldier is an integral part of overall Army capability and functioning. Although only becoming full-time when participating in training exercises or when called on for operations, these personnel are generally expected to perform at a level commensurate with full-time soldiers of the same rank and trade. Due to their transitions between civilian and military employments, they are typically exposed to less chronic military physical conditioning than their full-time counterparts. This reduced chronic conditioning, but requirement to perform the same tasks at the same level as full-time soldiers, may leave the reserve soldier at a higher risk of injury when performing military tasks. While this hypothesis was supported by the Defence Health Status Report (2000), the data used to affirm the differences in injury rates between these two populations was limited in both breadth and depth, was not specific to the Australian Army, and is now quite dated. On this basis, the aims of this program of research were to: profile injuries in Army Reserve (ARES) personnel; compare this profile with that of the Australian Regular Army (ARA) personnel from the same time period; and further investigate the patterns, sources and mechanisms of injuries in this Army Reserve population.

An initial step in this program of research was to critically review the literature investigating differences between part-time and full-time tactical personnel (military, police and firefighters). The review, reported in *Chapter 1*, found that many tactical populations comprised both full-time and part-time personnel. Despite their differing levels of time contribution when compared to their full-time counterparts, reserve personnel are typically expected to perform similar tasks at an equivalent level. A total of six, moderate quality, studies met the eligibility criteria for the critical literature review. These studies found that physical characteristics (e.g. body weight, body mass index [BMI] and fat mass) and physical performance (e.g. push ups and shuttle runs) of part-time personnel differ from those of full-time personnel. The conclusions were that part-time personnel typically exhibit higher BMI and body fat levels, lower aerobic capacities and lower strength than full-time tactical personnel. Findings regarding the differences in aerobic fitness and strength were, however, variable. Such differences between part-time and full-time personnel may impact the rates and patterns of injuries sustained while on duty. Due to the limited number of studies of high methodological quality, it is suggested that the results of the critical review be interpreted with

caution, and that more research on the differences between part-time and full-time personnel is required.

To inform the studies documented in this report, (which were designed to profile injuries in the Australian ARES and compare these profiles to those of ARA personnel), Workplace Health and Safety (WHS) incident and injury data and population data for both ARES and ARA personnel were obtained for the period 01 July 2012 to 30 June 2014. Data from the Workplace Health, Safety, Compensation and Reporting (WHSCAR) database were extracted and provided in a non-identifiable form by an administrator of this database of the Australian Department of Defence. A total of 15065 WHS incidents were reported across the two-year period of the study, and data from these incident records were used in the studies undertaken.

The study reported in *Chapter 2*, investigating the patterns of reported WHS injuries of both ARES and ARA personnel, found differences between the two populations. The *per capita* incidence rates for WHS incidence and injuries (i.e. based on the number of soldiers rather than the full-time equivalent numbers) were lower for the ARES than for the ARA. A higher proportion of ARES incidents arose from combat training, manual handling and patrolling when compared to incidents in the ARA. As expected, sporting incidents represented a higher proportion of incidents in the ARA population than in the ARES population, while both populations reported similar proportions of incidents occurring during physical training. It was concluded that combat orientated training, in particular, requires regular training and careful risk management to ensure adequate conditioning and prevention of injuries amongst ARES personnel.

A subsequent study, reported in *Chapter 3*, went a step further by taking into account ARES days of active service, or full-time equivalent personnel numbers, when examining differences between ARES and ARA populations in incidence rates of WHS incidents and injuries. The study found that the incidence rates for reported WHS incidents in the ARES and the ARA were, respectively, 34 and 23 incidents, resulting in 31 and 17 injuries per 100 person-years of active service. By comparison, the injury incidence rates reported in the Defence Health Status Report (2000) for part-time and full-time Australian Defence Force populations, respectively, were 29 and 9 injuries per 100 person-years—not dissimilar to the current findings. However, other published Army injury reports, based on ‘point-of-care’ data capture, have cited much higher soldier injury incidence rates,

ranging from 81 to 300 injuries per 100 person-years. It is likely that substantial under-reporting of WHS incidents via the WHSCAR system has contributed to this observed difference in injury reporting rates, given that the point-of-care Army injury surveillance systems have typically recorded 3–8 times the rates of injuries calculated for ARES and ARA populations in the current study based on WHSCAR data for the Australian Army. In addition, since ARES personnel (unlike ARA personnel) are not entitled to free medical care, they may also be more likely to report injuries as a means of claiming reimbursements for medical costs they incur due to work-related injuries. Further research on ARES/ARA differences is warranted, using point-of-care injury reporting systems. In addition, WHS reporting system developers should consider incorporating point-of-care incident reporting.

The study reported in *Chapter 4*, comprising an initial investigation of the most common injury types in ARES personnel, found that the knee was the most frequently injured body location. The most common nature of injury at the knee was soft tissue injury due to trauma. Reported knee injuries in ARES personnel mostly occurred during combat training and physical training and were due to falls, muscular stress with no objects being handled, and contact with moving and stationary objects. Injury risk management efforts in ARES personnel should consider these findings when prioritising sources and causes of injuries for management.

The final paper, *Chapter 5*, in this program of research has provided a global overview of optimal conditioning practices for part-time personnel, in light of the results of the preceding studies in this research program and the evident need for further, more focussed research on this topic. With the requirement of part-time personnel to perform occupational and operational tasks akin to those of their active-duty counterparts, the physical and performance capacities of these populations need to be similar. As suggested by the literature review, part-time personnel may have lower levels of chronic conditioning than their full-time counterparts. The results are higher BMI and body fat measures and lower measures of fitness—the downstream effects of which increase their risk of injury. The recommendations compiled in this paper, based on published reports of previous research on this topic, include a need to improve the fitness and performance of part-time personnel, with 3 days/week aerobic training and 2 days/week strength training required (although some days may include both). Of note, the ability of the Army and the individual to increase the physical

fitness of part-time personnel is affected by many factors, including civilian commitments and the ability to perform combat orientated training. To ensure compliance and motivation of part-time personnel away from their units, both general and occupationally-orientated training could be tracked by using computer applications and/or by formal attendance at evening training groups in their local community. To achieve this goal, the use of digital log books, performance monitoring devices (heart rate and Global Positioning Systems) and community-based training groups should be considered.

In conclusion, while current data limitations make it difficult to derive definitive findings, it is possible that ARES personnel do experience 30%–50% higher rates of WHS incidents and injuries than their full-time counterparts, when full-time equivalence (or actual days of active service) is considered. The types of activities from which ARES injuries arise do differ to those of the ARA; thus, differing exposures to particular activity types (e.g. less Army-organised combat orientated activity participation for ARES soldiers) may be one reason for the observed differences in reported incidence rates of WHS incidents and injuries. Other reasons may include (but are not limited to) possible differences between ARES and ARA in reporting thresholds; lower levels of chronic conditioning in ARES personnel; typically lower levels of general physical fitness in ARES personnel; and reduced opportunities for optimal training in ARES personnel (partly due to their competing civilian work obligations). Chapter 5 has provided specific recommendations regarding training optimisation of conditioning approaches for ARES personnel, including the use of technology to enhance group training and benchmarking opportunities; the use of alternative training equipment better suited to a civilian context; an increased accountability of ARES personnel for their training engagements; and specific guidelines regarding optimal frequency and intensity of training.

The program of research has highlighted several research and practice gaps, which warrant further research and practice development. First, developers and administrators should consider incorporating ‘point-of-care’ incident/injury reporting within WHS incident reporting systems to enhance data capture (and thus statistical power) to detect existing and emerging WHS incident and injury risks, and to more reliably inform future studies. Second, key sources and patterns of injuries in ARES personnel warrant dedicated research and practice improvement efforts to investigate and

remediate the causes of injuries. Third, rigorous intervention studies and evaluations of practice changes are needed to confirm the effectiveness of practice approaches recommended in the current report. Finally, well-designed, pragmatic qualitative research would also be beneficial to explore in depth the experiences of ARES personnel in relation to:

- maintaining physical conditioning;
- reducing risks of WHS incidents and injuries;
- balancing civilian and military occupational commitments; and
- barriers to and facilitators for optimal engagement in training for military physical conditioning and military skill development.

Given the identified research and practice gaps, key recommendations are provided in *Chapter 6*. These are as follows: 1) improved incident surveillance data collection; 2) further identification of key sources and patterns of injuries in ARES personnel; 3) the establishment of a detailed ARES fitness profile (to be compared with that of ARA personnel), and the identification of ARES specific barriers to physical training; and 4) implementation of strategies to increase physical training and improve fitness in order to specifically reduce identified types of injuries suffered by ARES personnel. For these recommendations to be actioned, it will also be important that Army policy and governance explicitly support and encourage implementation of such strategies.

*Chapter 7* provides an insight into the future research and directions to be taken by the Tactical Research Unit (TRU), Bond University, following the formal completion of this research (funded by an Establishment Grant from the Defence Health Foundation). With an aim to further advance the findings of this program of research, the TRU has sought grant funding through the Army Research Scheme and will continue to seek funding through other sources. In addition, the current data will be further investigated to provide a more detailed understanding of the injuries sustained by ARES personnel.

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## BACKGROUND

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Australian Army Reserve (ARES) personnel are often required to complete the same physical fitness assessments (Basic Fitness Assessment; Physical Employment Standards), participate in the same field exercises (e.g. Exercise HAMMEL), and to be deployed on the same combat operations as Australian Regular Army (ARA) personnel. However, ARES personnel typically do not experience the same degree of chronic military physical conditioning as ARA personnel, due to their shorter bouts of active service. This difference is likely to increase injury rates for ARES personnel undertaking military duties, but actual rates have previously been unknown. The key sources and injury patterns in ARES personnel have also been unknown, and guidance on these topics and on ways to prevent ARES injuries while optimising occupational performance have therefore been largely unavailable to commanders and soldiers.

In response to this gap in previous research and practical guidance, the program of research reported here was supported by an *Establishment Grant* from the Defence Health Foundation. For the first time in Australia, studies were conducted to specifically investigate and examine the rates, types and sources of Work Health and Safety (WHS) incidents and injuries sustained by ARES personnel during active service. This study also compared the patterns of WHS incidents and injuries suffered by ARES personnel with those suffered by ARA personnel. The information provided in this report is crucial for guiding future injury risk management by ensuring it is appropriately targeted and designed to reduce rates of injury in ARES personnel during active service. Differences in military physical conditioning opportunities have meant that WHS incident and injury rates in ARES personnel are likely to be higher than those in ARA personnel, but the rates and patterns of WHS incidents and injuries in ARES personnel have previously been unknown.

This program of research analysed records of WHS incidents and injuries for both ARES and ARA personnel, which were sustained over the two-year period spanning 01 July 2012 to 30 June 2014, and formally reported and recorded on the Workplace Health, Safety, Compensation and Reporting (WHSCAR) database of the Australian Department of Defence. These incident records were extracted and made non-identifiable by the WHSCAR system administrators before being checked for integrity and duplicates and then analysed by the research team. Data were also gathered

indicating the numbers of ARES and ARA personnel serving during this period, and also the numbers of days they were engaged in active service from the Australian Army's personnel datasets. The data were used in the studies that comprised this program of research, and particularly to enable calculation of incidence rates for WHS incidents and injuries.

Ethics approval for the program of research was obtained from the Australian Defence (LERP 14-024) and Bond University (RO 1907) Human Research Ethics Committees. The WHSCAR database of the Australian Department of Defence was searched by its administrators—on behalf of the researchers, and in accordance with a detailed research request—to identify all records of reported WHS incidents and injuries affecting ARES and ARA personnel between 01 July 2012 and 30 June 2014, inclusive. The WHSCAR database is designed to capture all incident reports submitted in the reporting of Workplace Health and Safety incidents (including injuries). The extracted dataset was made non-identifiable by the WHSCAR administrators before delivery to the researchers. Data inclusion criteria were as follows: the incident affected an ARA or ARES member; the incident occurred while the person was 'on duty'; and the incident occurred between 01 July 2012 and 30 June 2014, inclusive. Subsequently, injuries arising from reported WHS incidents were identified in the dataset for separate analysis. The total days of exposure to active military service for the ARA and ARES personnel in the study period were ascertained from centrally-held Army personnel statistics. Unfortunately, details of the nature of activities undertaken by personnel while on duty during active service days were unavailable from Army datasets; only the activities being undertaken at the times that the reported incidents and injuries occurred could be ascertained, in this case from the WHSCAR dataset.

The raw, non-identifiable WHSCAR incident dataset was manually cleaned by the research team to remove duplicate records and any records that failed to meet inclusion and met exclusion criteria. Using the Type of Occurrence Classification System (TOOCS) codes, each recorded incident was categorized by the researchers, with free-text narrative fields used to verify or amend category coding and to increase data precision. Descriptive and inferential statistical analyses were employed to examine reported injuries and describe and compare, between ARA and ARES populations, the types and incidence rates of WHS incidents and injuries sustained, the body sites of the injuries, the natures of the injuries, the mechanisms of injury, and the activities being conducted at the times the



injuries occurred. Data were analysed using the IBM Statistical Package for the Social Sciences (SPSS) Version 20.0, with the level of statistical significance set *a priori* at 0.05.

The analyses conducted on the data gathered from these sources were designed to describe and compare the patterns of WHS incidents and injuries in ARES and ARA personnel and to identify the key sources of these incidents and injuries, where possible. Recommendations are provided in Chapter 6—based on the results of this program of research, and informed by the results of previous injury prevention and risk management research—to guide future research and injury risk-management efforts for the benefit of ARES personnel.

This program of research provides the first known detailed profile of ARES WHS incidents and injuries and the first known detailed comparison specifically between ARES and ARA injury profiles. On this basis, the findings of this program of research will valuably inform future injury risk management and physical conditioning approaches for ARES personnel. Previous research conducted by the current research team (of the type conducted here, but focused on ARA rather than ARES personnel) has resulted in immediate and substantial reductions in the rates and associated health consequences of injury to ARA personnel<sup>1-4</sup>. It is anticipated that similar immediate health benefits will accrue for ARES personnel, following implementation of the recommendations of this report.

Following development of this proof of concept, the extension and translation into practice of the findings and recommendations of this program of research over forthcoming years is anticipated to lead to further reductions in ARES injury rates and consequences. Injuries affect not only the injured Defence personnel but also their families, through often long-term effects on the injured person's job security (risk of medical discharge), stress and mental health, fitness to deploy, and the flow-on effects to their chances of promotion, financial security, health expenditure, opportunities for posting to desired geographic locations and relationships. This list is not exhaustive. On this basis, this research and its translation into practice have a strong potential to markedly enhance the wellbeing and quality of life of ARES personnel and their families, both during and after service.

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## RESEARCH AIMS AND OVERVIEW

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The aims of this program of research were:

- to establish the WHS incident and injury profiles of ARES personnel, sustained during active service;
- compare these WHS incident and injury profiles to those of ARA personnel;
- examine in detail the reported sources, types and mechanisms of WHS incidents and injuries in ARES personnel, with comparison to ARA personnel; and
- establish recommendations to guide future WHS incident and injury risk management for ARES personnel.

The first chapter of this report contains a critical review of existing literature, which compared both physical characteristics and performance of part-time and full-time tactical personnel. The review highlights six available research reports (included in the review), which encompass various populations of tactical personnel regarded as being employed part-time. The differences between part-time and full-time tactical personnel in physical conditioning attributes and the impacts of these differences are subsequently discussed.

The second chapter documents the numbers of reported WHS incidents and injuries that were reported in both the reserve and regular army populations within a two-year period. It additionally quantifies and compares between ARES and ARA populations the factors involved in reported workplace health and safety incidents and injuries. It examines the body locations, nature and mechanisms of reported injuries, and examines which activity or activities were being performed at the time these incidents occurred. This chapter is designed to identify patterns of both WHS incidents and injuries so as to guide recommendations for the reduction and optimal management of future incidents.

The incidence rates of work health and safety incidents and injuries reported by ARES and ARA personnel are examined and compared in Chapter 3. Due to the detrimental effects of injuries on overall Army capability, the retrospective cohort study reported in Chapter 3 compares incidence

rates of ARA and ARES WHS incidents and injuries relative to days of active service. Comments on the discrepancies in rates of reported incidents and injuries between the ARES and ARA are provided, along with recommendations for future reporting system developers and operators.

An overview of an ongoing in-depth analysis of the injuries suffered in the ARES and ARA across a two-year period is reported in Chapter 4. Information including the locations, activities, types and mechanisms of injury amongst reservist soldiers is provided. This breakdown of injury details is a further aid in both understanding common injuries amongst reserve soldiers and, in particular, for informing future injury minimisation strategies in the ARES.

Chapter 5 provides a supplemental paper that theorises the means to optimise conditioning approaches for ARES soldiers, in order to minimise the differences in physical and performance characteristics found in Chapter 1 and, subsequently, to decrease the incidence rates found in Chapter 3. The journal article in Chapter 5 provides guidelines for both aerobic fitness and strength training, and recommendations for improving training compliance and motivation of reservists when they are away from their units.

A summary of conclusions from this report can be found in Chapter 6. In addition, key recommendations arising from the research and aimed at reducing WHS incident and injury risks among ARES personnel are provided.

Chapter 7 extends the recommendations to research, noting the continued gaps in the research literature and indicating the nature of the research that is still required in this area.

Appendices are attached for reference, which support the various chapters of the report and contain copies of some presentations and publications.

## CHAPTER 1 – A CRITICAL REVIEW OF THE LITERATURE

---

### PREFACE

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Tactical personnel such as military, law enforcement and fire and rescue personnel routinely perform physically strenuous occupational tasks, requiring strength, endurance and cardiovascular fitness. Tactical populations are comprised of part-time and full-time personnel, with both groups expected to perform similar tasks at an equivalent level. The purpose of the research reported in this chapter was therefore to critically review existing literature comparing physical characteristics and physical performance of part-time and full-time tactical personnel.

The critical review paper included as part of this chapter has been published in the *Journal of Military and Veteran's Health*:

McDonald, D., Pope, R. & Orr, R. (2016). Differences in physical characteristics and performance measures of part-time and full-time tactical personnel: A critical narrative review. *Journal of Military and Veteran's Health*, 24(1) pp. 45-55.

This critical review was also presented at the Australasian Military Medicine Association Conference in Hobart, Australia, 09-11 October 2015:

McDonald, D., Orr, R. & Pope, R. (2015). Differences in physical characteristics and performance measures of part-time and full-time tactical personnel: A critical narrative review. Podium presentation at the Australasian Military Medicine Association Conference, Hobart, Australia, 09-11 October 2015.

The abstract from the conference presentation was published in the *Journal of Military and Veteran's Health*, 23(4), pp 24-25.

The PowerPoint presentation associated with that presentation, given on 09 October 2015, can be found in Appendix 1.

## DIFFERENCES IN PHYSICAL CHARACTERISTICS AND PERFORMANCE MEASURES OF PART-TIME AND FULL-TIME TACTICAL PERSONNEL: A CRITICAL NARRATIVE REVIEW

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### INTRODUCTION

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Tactical personnel such as those from military, law enforcement and fire and rescue services, whether employed on a part-time or full-time basis, are routinely required to perform physically strenuous occupational tasks which require a high level of fitness<sup>5-7</sup>. Physical performance measures have therefore been used to inform a selection of applicants for these tactical organisations, ensuring recruits can successfully perform the required arduous occupational tasks<sup>8</sup>. To this end, minimum entry standards have been set by some tactical organisations to ensure new recruits are capable of meeting the physical demands of the job<sup>9</sup>.

Moving beyond applicants and new recruits in the tactical services, it is important to recognise that fully qualified tactical personnel must also maintain adequate muscular strength, endurance and cardiovascular fitness to enable them to continue to effectively perform the required occupational tasks and meet mandatory fitness requirements<sup>10</sup>. Common physical measurements used to assess tactical personnel include anthropometric measures, measures of cardiovascular endurance, field tests and performance in simulated occupational tasks<sup>11-16</sup>. Research also suggests that physical fitness plays a significant role in determining injury risks. Some examples of this are as follows: (a) a decreased level of fitness increases injury risk during load carriage tasks<sup>17</sup>; (b) Australian Army recruits who have low aerobic fitness are at a 25% increased risk of not completing training due to injury<sup>18</sup>; and (c) low aerobic and muscular endurance have consistently been associated with increased injury risk<sup>19</sup>.

To date, research comparing fitness and anthropometric differences in tactical personnel has typically focussed on: a) male to female differences and the impacts of gender on meeting physical performance standards<sup>9</sup>; b) occupational task requirements across different occupations, e.g. law enforcement and fire and rescue<sup>10</sup>, and c) risks of injury, illness, training failure and attrition in tactical personnel with differing physical characteristics and physical capacities<sup>18,20-22</sup>. However,

one area that is starting to gain interest in research and strategic planning is the comparison of part-time and full-time personnel in tactical populations.

Many tactical populations are comprised of both relevantly qualified part-time and full-time personnel, with both well represented in military, law enforcement, and fire and rescue services across the world. Occupational expectations are similar in both part-time and full-time personnel, with both groups typically having to pass the same physical capacity tests (e.g. Basic Fitness Assessment or Physical Employment Standards) and being expected to perform tasks at an equivalent level <sup>13,14</sup>. Despite the fact that part-time tactical personnel are tending to be utilised at a higher rate than previously has been the case, and despite part-time personnel being deployed on the same combat operations and in the same roles as full-time personnel <sup>23</sup>, their on-the job physical training typically continues to be at a lower frequency than that of full-time personnel <sup>14,15,24</sup>. Part-time personnel often have to balance other occupations and work demands with their tactical role, and so frequently have to be responsible for their own individual, self-directed physical training sessions <sup>14,15</sup>. These factors have the potential to contribute to differences in fitness levels between part-time and full-time tactical personnel.

With previous research showing a strong link between the level of physical conditioning and injury risk <sup>18,21,22</sup>, any differences between part-time and full-time tactical personnel in levels of specific conditioning, when considered against the requirement for part-time personnel to perform tasks at a similar level to that required of full-time personnel, are likely to increase risks and rates of injury among part-time personnel when they undertake tactical duties. This likelihood is supported by findings of the Australian Defence Health Status Report (2000) that rates of reported injuries in part-time Australian Defence Force personnel during physical training and military training, when adjusted for days of service, appeared to be three times higher than those of their full-time counterparts <sup>25</sup>.

The aim of this review is to critically appraise and discuss the findings of existing research that has compared the physical characteristics and physical performance capacities and associated physical training or physiological work demands of part-time and full-time tactical personnel.

## METHODS

## LITERATURE SEARCH, SCREENING AND SELECTION

To identify all relevant literature for this review, several search strategies were employed. Initially, key search terms were entered into five literature databases, with the exact terms and use of Boolean operators modified to suit each individual database's search capabilities. The databases searched and search terms used are detailed in Table 1.

TABLE 1: DETAILS OF LITERATURE SEARCH: DATABASES USED, SEARCH TERMS AND INCLUSION FILTERS

Database	Filters applied	Number after inclusion criteria applied	Number after exclusion criterion applied	Duplicates	New articles
<b>PubMed</b>	1994-2014	994	10	0	10
<b>CINAHL</b>	1994-2014	314	5	5	0
<b>EBSCO-Academic search complete</b>	1994-2014, Scholarly peer reviewed journals, academic journals	1411	6	6	0
<b>EBSCO-SPORTDiscus</b>	1994-2014	169	3	1	2
<b>Web of Science</b>	1994-2014, English, article	1030	9	9	0

Search terms: ("full-time" OR "part-time" OR "reserve") AND ("home guard" OR "army" OR "defence" OR "defense" OR "police" OR "military" OR "soldiers" OR "firefighters" OR "first responder").

To the extent possible in each database, the inclusion and exclusion criteria for the review were applied as filters during the search of the databases. The inclusion criteria were: (a) the study was published in the English language; (b) the study involved human participants; (c) the study was published in 1994 or later; (d) the study involved participants from one of three tactical populations (military, law enforcement or firefighters/first responders); and (e) the study included both part-time and full-time participants, to allow for direct comparison. The exclusion criterion was any study that did not examine anthropometric or physical performance measure(s).

Following the initial search, the inclusion and exclusion criteria were manually applied during initial screening of all article titles and abstracts. Once potential articles were selected by this screening process, duplicates were removed and copies of the remaining articles were obtained in



full text. Six colleagues with experience in this field as researchers and service providers were asked to identify any additional articles for review, and these were similarly obtained in full text. All full text articles were once again subjected to the inclusion and exclusion criteria to arrive at the final included set of articles. The reference lists of these final included articles were searched by hand to identify any additional, pertinent references, but yielded none.

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### CRITICAL APPRAISAL

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Included articles were each critically appraised using the Downs and Black protocol <sup>26</sup> to determine their methodological quality. The Downs and Black protocol is comprised of a 27-item checklist that can be used to appraise both randomised controlled trials and other quantitative observational studies. The checklist contains five subcategories, including *reporting quality*, *external validity*, *internal validity - bias*, *internal validity - confounding*, and *statistical power*. Most checklist items are scored dichotomously, such that 'yes' equals one point and 'no' or 'unable to determine' equals zero points. Two questions are scored on a larger scale. Item five, in the *reporting quality* subcategory, can be scored from zero to two points, with one point given for 'partially describing confounders' and two points for 'clearly describing confounders'. Item 27, within the *statistical power* subcategory, is normally scored from zero to five points based on the adequacy of *a priori* estimated statistical power yielded by the sample size. For the purposes of our study, however, a modified Downs and Black approach was employed, as previously described <sup>27</sup>, where item 27 was scored dichotomously, with one point awarded where the results of a statistical power or sample size calculation were reported and zero points awarded where such was not reported.

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### DATA EXTRACTION AND ANALYSIS

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All of the included studies were independently rated by two authors (DM, RO), with the level of initial agreement determined by a Cohen's Kappa Analysis of all raw scores (28 item scores per paper). Any disagreements in points awarded for individual items were settled by discussion of reasons for points awarded and subsequent consensus. The third author (RP) was available if needed to mediate final scores assigned for any items, but mediation was not required. The final total score from the Downs and Black checklist for each article was converted to a percentage by dividing the sum of each total score by 28 (total possible points) and then multiplying this figure by 100. To provide a further indication of the quality of the included articles, the total raw scores for all articles were graded using the grading system proposed by Kennelly <sup>28</sup>. Kennelly proposed that a total Downs and Black score greater than or equal to 20 should be considered a *good quality* study, scores between 15 and 19 reflect a *fair quality* study, and scores of 14 and below indicate a *poor*

*quality* study<sup>28</sup>. Given the modification of the checklist to a score out of 28, the grading scales suggested by Kennelly were adapted to a percentage score, allowing comparison to the percentage scores employed in this review. As such, a score greater than or equal to 62.5% should be considered a good quality study, scores between 47% and 62.5% reflect a fair quality study, and scores of below 47% indicate a poor quality study.

Data were systematically extracted from each article to populate a summary data table. Data analysis involved critical narrative synthesis of the key findings of individual articles, in which the methodological quality of each study was considered.

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## RESULTS

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### SEARCH AND SELECTION RESULTS

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The results of the literature search and selection processes are depicted in the PRISMA flowchart at Figure 1. In total, six articles investigating physical characteristics and physical performance measures in part-time and full-time tactical personnel<sup>11-16</sup> were identified, selected and retained for evaluation.

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### KEY DATA AND METHODOLOGICAL QUALITY OF INCLUDED STUDIES

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Table 2 provides key data extracted from each included study, along with the methodological quality score yielded by the critical appraisal of each article. These methodological quality scores, based on the Downs and Black checklist<sup>26</sup> ranged from 57% to 61%, indicating that the available and included studies were all of only *fair quality*, according to the grading system proposed by Kennelly<sup>28</sup>. The kappa statistic for inter-tester agreement of the methodological quality of the studies indicated an ‘almost perfect’ agreement ( $k=0.923$ )<sup>29</sup>.

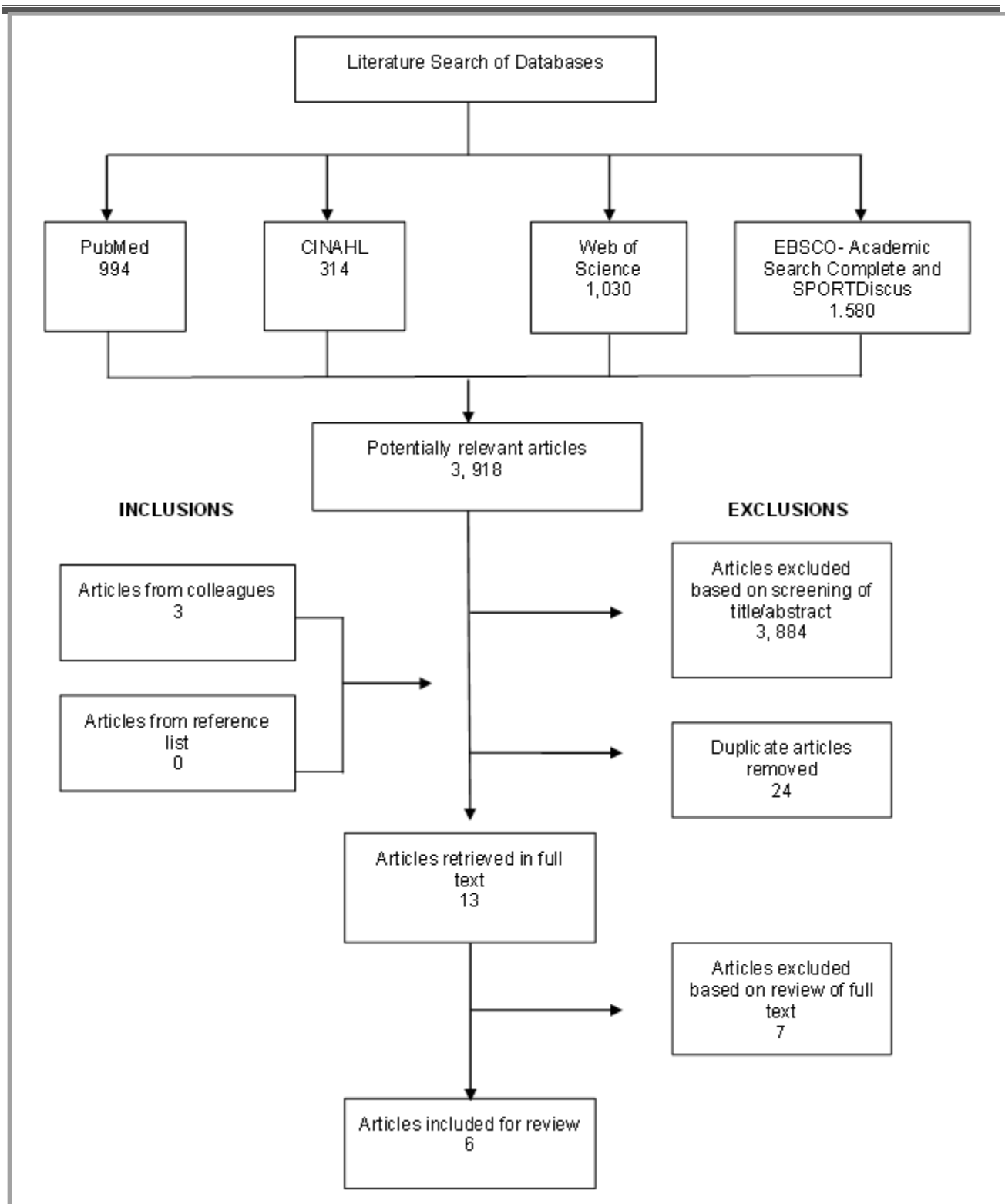


FIGURE 1: PRISMA FLOWCHART DEPICTING THE LITERATURE SEARCH AND SELECTION PROCESS.

TABLE 2: SUMMARY AND CRITICAL APPRAISAL OF INCLUDED ARTICLES IN THIS REVIEW

Author Year Title	Participants	Physical Characteristic or Performance Measured	Outcome Measures	Results	Critical Appraisal Score
<b>Dawes et al. 2013</b>	Two groups of Special Weapons and Tactic Teams, all males: (retrospective data)  21- Part-time  29- Full-time	-Anthropometrics -Muscular endurance -Lower-body power -Anaerobic endurance	-Anthropometric Measurements (height and weight) -Three site skin fold (Body fat %) -BMI -Two-minute push-up to fatigue -Two-minute sit-up -Vertical jump height -300 Metre run	Significant differences between part-time and full-time Special Weapons and Tactics (SWAT) in bodyweight, percent body fat, fat mass and Body Mass Index (BMI).  Part-time SWAT officers mean percent body fat was 19.5% compared to full-time at 10.71%.  Part-time SWAT officers mean $\pm$ SD fat mass $18.28 \pm 5.2$ kg compared to full-time at $9.1 \pm 2.7$ kg.  Mean $\pm$ SD BMI of part-time SWAT was $30.1 \pm 3.2$ (kg/m <sup>2</sup> ) and for full-time SWAT was $26.3 \pm 2.3$ kg/m <sup>2</sup> .  Full-time SWAT performed better on muscular endurance, lower body power and anaerobic endurance tests than part-time SWAT officers. Part-time SWAT: mean $\pm$ SD vertical jump height $55.40 \pm 6.65$ cm, $56.52 \pm 12.89$ repetitions in 2-minute maximal sit up test, $64.52 \pm 14.05$ repetitions in 2-minute maximal push up test. Full-time SWAT: mean $\pm$ SD vertical jump height $68.94 \pm 9.55$ cm, $82.7 \pm 8.52$ repetitions in 2-minute maximal sit up test, $89.46 \pm 12.95$ repetitions in 2-minute maximal push up test.  Part-time officers' mean $\pm$ SD age was $36.05 \pm 4.06$ years and for full-time officers was $40.1 \pm 6.4$ years.	57%

<b>Williams 2005</b>	Two groups of military recruits and one control group, all males:	-Aerobic fitness	-Body Mass, Stature	Both the Reserve and Regular recruit training programs resulted in improvements in body composition and aerobic fitness.	61%
		-Body composition	-% Body Fat	Reserve and Regular training significantly increased fat free mass and Maximal Volume of Oxygen (VO <sub>2max</sub> ) and decreased percentage body fat.	
			-Shuttle run (VO <sub>2max</sub> )		
	14- Territorial Army (Reserve group)		-Training Log	Reserve training effected greater reductions in body mass and greater increases in fat free mass. The training given to Regular soldiers effected greater improvements in VO <sub>2max</sub> than Reserve training.	
	11- British Army (Regular group)			Reserve soldier organised training volume was 10 x 45 minutes over 11 weeks, concentrated in five training weekends. Regular soldier organised training volume was 90 x 40 minute periods over 11 weeks.	
	20- Controls			Reserve soldier mean $\pm$ SD BMI, body fat (%), estimated VO <sub>2max</sub> , and age were $23.5 \pm 4.4$ kg/m <sup>2</sup> , $14.0 \pm 4.4$ %, $40.9 \pm 6.1$ mL/ kg/ min and $23 \pm 5$ years, respectively.	
				Regular soldier mean $\pm$ SD BMI , body fat (%), estimated VO <sub>2max</sub> , and age were $22.0 \pm 2.1$ kg/m <sup>2</sup> , $11.8 \pm 3.7$ %, $44.8 \pm 4.9$ mL/kg/min, and $18 \pm 1$ years, respectively.	
				Concluded it is likely that training adaptations would be enhanced in Reserves with increased training volume.	

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Williams & Evans 2007	Two groups of British Army male soldiers from the Royal Corps of Signals:  23- Reserve  15- Regular	- Body composition	-% Body Fat	No statistically significant differences between Reserve and Regular soldiers for any variables assessed.  Reserve soldiers' mean $\pm$ SD body fat (%), fat free mass, estimated $VO_{2max}$ , and age were $20.4 \pm 3.5$ %, $63.8 \pm 6.2$ kg, $47.2 \pm 3.4$ mL/kg/min, and $29 \pm 6$ years, respectively.  Regular soldiers' mean $\pm$ SD body fat (%), fat free mass, estimated $VO_{2max}$ and age were $18.9 \pm 4.0$ %, $63.1 \pm 5.4$ kg, $49.5 \pm 4.8$ mL/kg/min, and $25 \pm 6$ years, respectively.  Reserve soldier military physical training was 1 x 45 min per month. Regular soldier military physical training was 10 x 45 min per month $\pm$ 1 or 2 sessions.  Reserve soldiers predominantly trained outside of duties while Regular soldiers' training took place both within and outside of duties.  Concluded that it appears that both Reserve and Regular soldiers have sufficient training volume and intensity to maintain similar performance levels between the two groups.	61%
		- Cardiovascular fitness	-Fat-free Mass		
		- Physical activity levels	-Baecke physical activity questionnaire		
		- Strength	-Shuttle run ( $VO_2_{max}$ )		
			-Repetitive lift and carry  -Single lift maximum		

<b>Lindberg &amp; Malm 2014</b>	Questionnaire sent out to Fire and Rescue services in 2000 and 2010.	Self-rated physical demands of work tasks, including:	Questionnaire examined self-ratings of:	Significant differences observed between part-time and full-time firefighters.	57%
	Total questionnaires sent out were 160.	- Aerobic demands	- Aerobic demands of work tasks	More part-time firefighters rated questions regarding aerobic demands as 'I don't know' where full-time firefighters rated them as 'somewhat hard, hard, or very hard.'	
	Total respondents in 2000= 125, with: 94% males & 6% females; & 46% part-time and 54% full-time.	- Muscle strength requirements	- Requirements of hand muscle strength	More part-time firefighters rated questions regarding muscle strength demands as 'I don't know' where full-time firefighters rated them as 'high or very high'.	
	Total questionnaires sent out in 2010 were 84.	- Ranked worked posture requirement	- Requirements of arm muscle strength	The most physically strenuous work tasks, considering aerobic fitness, muscle strength, work posture and body control in both full-time and part-time personnel were:	
	Total respondents in 2010 = 68, with: 91% males & 9% females; & 47% part-time and 53% full-time.	- Ranked body control requirement	- Requirements of leg muscle strength	- Smoke diving upstairs	
			- Requirements of trunk muscle strength	- Victim rescue	
			- Posture requirements	- Carrying a stretcher over terrain	
				- Pulling a hose	
				Concluded that work related exercise is important to address the variation in on-the-job tasks performed by full-time and part-time firefighters.	

<b>Wynn &amp; Hawdon 2011</b>	Two groups of Fire and Rescue Service recruits involving males and females:	Cardiorespiratory fitness exhibited in two conditions: (1) application and (2) non-application of a cardiorespiratory fitness standard of 42 mL O <sub>2</sub> /kg/min.	Cardiorespiratory fitness in mL O <sub>2</sub> /kg/min if available.	Part-time recruits with higher VO <sub>2max</sub> had lower incidence of injuries.	57%
	Group 1: Minimum recruit cardiorespiratory fitness standard of 42 mL O <sub>2</sub> /kg/min:  48 Part-time  308 Full-time    Group 2: No direct cardiorespiratory fitness standard:  206 Part-time  198 Full-time		Chester step test-submaximal estimate of VO <sub>2max</sub> .	Full-time recruits with no cardiorespiratory standard were more likely to get injured.  Part-time recruits' mean ± SD estimated VO <sub>2max</sub> and age were 47.69 ± 7.64 mL/kg/min and 28.91 ± 7.86 years, respectively.  Full-time recruits' mean ± SD estimated VO <sub>2max</sub> and age were 50.10 ± 7.05 mL/kg/min and 27.8 ± 5.58 years, respectively.  Concluded that adverse health and employment outcomes are associated with the removal of a cardiorespiratory fitness standard. However, there was no evidence of adverse outcomes with a reduction in cardiorespiratory standard from 45 to 42 mL O <sub>2</sub> /kg/min.	



<b>Lindberg, Oksa &amp; Malm 2014</b>	Firefighters from Fire and Rescue services and male and female civilians in Northern Sweden.	-Physical capacity -Physically demanding work tasks -Laboratory tests -Field tests	Eight Laboratory tests: - Isokinetic maximal and endurance muscle power and dynamic balance  Ten Field tests: - Maximal and endurance muscle performance  Seven simulated firefighting work tasks	No overall statistically significant differences observed between part-time and full-time firefighters.  There were significant correlations between laboratory and field tests indicating that field tests may be used instead of costly and time-consuming laboratory tests.  Recommended tests to measure firefighter work capacity are maximal handgrip strength, bench press, chin-ups, dips, upright barbell row, standing broad jump, and barbell shoulder press.  Part-time firefighter mean $\pm$ SD BMI and age were $25 \pm 4.0$ kg/m <sup>2</sup> and $28 \pm 4.7$ years, respectively.  Full-time firefighter mean $\pm$ SD BMI and age were $25 \pm 1.3$ kg/m <sup>2</sup> and $39 \pm 9.1$ years, respectively.	57%
	The study included 38 participants: 10- Male Part-time firefighters 8- Male Full-time firefighters 8- Male civilians 12- Female civilians				

SWAT= Special Weapons and Tactics police. VO<sub>2max</sub> = Maximal volume of Oxygen. BMI = Body Mass Index

The critical appraisal indicated that the most common limitations of the included studies were a lack of blinding of subjects or assessors and a lack of random allocation to observed groups. Only one of the studies was considered to be representative of the entire population<sup>12</sup> when assessed using the Downs and Black protocol<sup>26</sup>. Participants and respondents in all other studies were selected on the basis of convenience<sup>11,13-16</sup> and in one study<sup>16</sup>, included only new recruits from the tactical population.

The participant samples in the included studies (Table 2) were heterogeneous, including only male personnel in three studies<sup>11,14,15</sup>, male and female personnel in two studies<sup>12,16</sup> and male tactical personnel and both male and female civilians in the remaining included study<sup>13</sup>. The tactical personnel investigated in the studies variably included military<sup>14,15</sup>, law enforcement (SWAT)<sup>11</sup>, and firefighter<sup>12,13,16</sup> personnel.

When comparing the physical characteristics and physical performance capacities of part-time and full-time tactical personnel (Table 2), a range of relevant measures were reported. Physical characteristics were measured using: (a) anthropometry<sup>11</sup> and (b) other measures of body composition<sup>14</sup>. Physical performance capacity was measured in terms of: (a) muscular endurance<sup>11,13</sup>, (b) lower-body power<sup>11,15</sup>, (c) anaerobic endurance<sup>11</sup>, (d) aerobic fitness<sup>14-16</sup>, (e) physical activity levels<sup>15</sup>, and (f) physical work capacity or work levels<sup>12,13</sup>.

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## SYNTHESIS AND DISCUSSION

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The aim of this review was to critically appraise and discuss the findings of existing research that has compared the physical characteristics and physical performance capacities and associated physical training or physiological work demands of part-time and full-time tactical personnel. Prior to synthesis and discussion of the results, it is important to note that the methodological quality of all six of the identified research reports of relevance to this aim was found to be of a *fair* quality. On this basis, caution should be applied to the interpretation of the results and their application in practice. Further research is needed to further elucidate this topic area and strengthen the associated evidence base. Considering this, it should be noted that the ability to conduct studies (notably

laboratory studies) within these populations is constrained by the challenges of access to, and time availability of, tactical personnel.

The magnitude of differences in physical characteristics and physical performance capacities between part-time and full-time populations varied across the included studies (Table 2). For example, Dawes et al.<sup>11</sup> reported significantly higher body weight, percentage body fat, fat mass and Body Mass Index (BMI) in part-time compared to full-time SWAT officers. Conversely, two of the research articles identified no significant differences between part-time and full-time personnel<sup>13,15</sup>. Williams et al.<sup>15</sup> found no differences between regular army and reserve army personnel when examining body composition, estimated  $\text{VO}_{2\text{max}}$ , muscular strength and self-reported physical activity levels. Likewise, Lindberg, Oksa and Malm<sup>13</sup> identified no significant differences in the work capacities of part and full-time firefighters (refer to Table 2 for full results). Overall, the evidence provided by these articles indicates that part-time personnel are typically less fit than their full-time counterparts, though this finding was not consistent across all studies. The part-time participants scored lower than full-time participants in estimated  $\text{VO}_{2\text{max}}$ <sup>14-16</sup>, and in two minute maximal sit up and push up repetitions<sup>11</sup>. In addition, part-time participants typically exhibited higher BMI ( $\text{kg/m}^2$ ) and body fat (%) levels than full-time participants<sup>11,14,15</sup>.

Reported physical training regimes for part-time personnel also varied across the papers (Table 2), but part-time personnel were consistently observed to have lower 'on-duty' training times and more intermittent periods of training while on active duty than their full-time counterparts. For example, the volume of training in 'on-duty' physical training regimes was found to be significantly less for the part-time army personnel in two studies<sup>14,15</sup>. Both studies led by Williams<sup>14,15</sup> found differences in on-duty training received. In these two studies, Reserve personnel received organised training involving 10 sessions of 45 minutes over 11 weeks, concentrated in five training weekends, or 1 session of 45 minutes per month, respectively<sup>14,15</sup>. In contrast, regular recruits received 90 40 minute sessions over 11 weeks, or 10 45 minute sessions per month, respectively<sup>14,15</sup> – nearly a tenfold greater on-duty training volume than that provided to Reserve personnel. The results of these studies indicate that the training provided to regular recruits yielded greater improvements in estimated  $\text{VO}_{2\text{max}}$  than that provided to Reserve recruits, while reservist training achieved greater improvements in fat-free mass<sup>14</sup>. A final example of physical training differences between full-time and part-time personnel that is noteworthy is the finding of Dawes et al.<sup>11</sup> that part-time

SWAT officers were largely responsible for developing and maintaining their own training program while their full-time counterparts were given 3-4 hours per week with a strength and conditioning specialist.

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## ANTHROPOMETRICS AND BODY COMPOSITION

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It has been theorised by Boyce et al.<sup>10</sup> that police officers who have increased body mass and are obese may not be able to perform their job as effectively as their counterparts with greater fat-free mass. This statement is supported by the research of Dawes et al.<sup>11</sup>, reported in the current review, who found that part-time SWAT personnel exhibited a higher level of fat mass (mean±SD 18.28 ± 5.2 kg) when compared to full-time personnel (mean±SD 9.1 ± 2.7 kg) and scored lower on tests related to muscular strength and endurance<sup>11,30,31</sup>. This is noteworthy for tactical populations generally, as many tactical tasks require significant amounts of muscle strength and endurance<sup>15,31</sup>.

In the current review, the studies that reviewed body composition<sup>11,13-15</sup>, found that the mean BMI of part-time tactical populations ranged from 23.5 ± 4.4 kg/m<sup>2</sup><sup>14</sup> to 30.1 ± 3.2 kg/m<sup>2</sup><sup>11</sup>, and that their body fat percentages ranged from 14.0 ± 4.4 %<sup>14</sup> to 20.4 ± 3.5 %<sup>15</sup>. Full-time populations exhibited mean BMI ranging from 22.0 ± 2.1 kg/m<sup>2</sup><sup>14</sup> to 26.3 ± 2.3 kg/m<sup>2</sup><sup>11</sup>, and body fat percentages ranged from 10.7 ± 2.6 (%)<sup>11</sup> to 18.9 ± 4.0 (%)<sup>15</sup>. These results support the finding noted above that part-time tactical personnel typically have higher BMI and body fat levels when compared to their full-time counterparts. These increased BMI and body fat loads in part-time personnel mean that these personnel may find physical tasks more difficult to complete and be more susceptible to injuries<sup>10,11,30,31</sup>.

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## PHYSICAL PERFORMANCE CAPACITIES

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### CARDIOVASCULAR FITNESS

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Cardiovascular fitness is an important attribute that enables tactical personnel to undertake their job duties<sup>14-16</sup>. When comparing cardiovascular fitness between part-time and full-time tactical personnel in the current review<sup>14-16</sup>, it was found that the estimated mean VO<sub>2max</sub> for part-time tactical personnel ranged from 40.9 ± 6.1 mL/kg/min<sup>14</sup> to 47.69 ± 7.64 mL/kg/min<sup>16</sup> and for full-time tactical personnel ranged from 44.8 ± 4.9 mL/kg/min<sup>14</sup> to 50.10 ± 7.05 mL/kg/min<sup>16</sup>. Based on these results, it appears that although part-time and full-time personnel have somewhat similar

cardiovascular capacities, capacities of part-time personnel are typically lower. However, in contrast to this finding, two other studies looking exclusively at *part-time* firefighters and home guard personnel found these part-time tactical personnel to have an estimated  $\text{VO}_{2\text{max}}$  of  $53 \pm 5$  mL/kg/min<sup>32</sup> and  $50.1$  mL/kg/min<sup>33</sup> - mean values that are higher than those in the studies reported in this review for part-time, and even for full-time, personnel. Further research is therefore needed to more fully investigate differences in aerobic fitness levels between full-time and part-time tactical personnel in varying roles and contexts.

Of note, increasing age corresponds with a decrease in aerobic fitness ( $\text{VO}_{2\text{max}}$ ). This correlation has been identified as potentially contributing to the decrease in physical fitness exhibited by part-time personnel<sup>34</sup>. However, the part-time and full-time participants in the studies included in this review were of similar ages. Part-time participants ranged from a mean of  $23 \pm 5$  years<sup>14</sup> to a mean of  $36.05 \pm 4.06$  years<sup>11</sup> and full-time participants from  $18 \pm 1$  years<sup>14</sup> to  $40.1 \pm 6.4$  years<sup>11</sup>. These similar age ranges among part-time and full-time personnel in the current review may explain some of the similarities observed between the part-time and full-time tactical populations in aerobic fitness levels.

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#### MUSCULOSKELETAL FITNESS

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Strength and endurance are important in the selection of tactical personnel<sup>11,14,15</sup>. These physical characteristics also influence the performance of job tasks and may play a role in injury prevention in these populations<sup>11,30</sup>. In the current review, Dawes et al.<sup>11</sup> found that, as a group, part-time tactical personnel exhibited lower strength and muscular endurance when compared to their full-time counterparts (Table 2). The associated scores for each test (Table 2) indicate substantial differences in muscular endurance and strength, which may lead to part-time tactical personnel being at a disadvantage and being more susceptible to injury when completing similar job tasks as full-time personnel<sup>10,11,30,31</sup>.

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#### TASK DIFFERENCES

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Molloy<sup>19</sup> suggests that there are several risk factors that increase training related injuries, and overall fitness levels play a significant part in influencing these injury risks<sup>19</sup>. The limited research available regarding part-time tactical personnel has indicated they typically exhibit lower levels of fitness when compared to their full-time counterparts, though this is variable<sup>11,13-15</sup>. The observed typically higher BMI and body fat levels combined with lower muscular strength and endurance in

part-time tactical personnel reported in this review are likely to place part-time tactical personnel at an increased risk of injury<sup>11,14,15</sup>. This hypothesis is supported by the Australian Defence Health Status report (2000), showing overall injury rates for part-time and full-time personnel of 28.5% and 9.1% of full-time equivalent personnel per annum, respectively<sup>25</sup>. Considering that part-time personnel are being employed in full-time duties at a higher rate than previously, these heightened risks for part-time tactical personnel have serious implications for the readiness of part-time personnel to complete similar tasks at equivalent levels of intensity to those undertaken by full-time personnel<sup>23,24</sup>. Given these findings and the moderate methodological quality of the studies included in the current review, high quality research investigating fitness differences between part-time and full-time tactical populations and profiling the physical characteristics, risks and rates of injuries, is needed.

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### IMPLICATIONS

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With occupational duties similar between part-time and full-time personnel, the reported typical differences in physical characteristics and physical performance capacities between part-time and full-time tactical personnel are likely to place part-time personnel at higher risk of injury and reduce their operational effectiveness when compared to their full-time counterparts<sup>11,13-15</sup>. The observed differences in access to organised, 'on-duty' physical training or a viable alternative may compound these issues and warrant additional consideration and remedial action.

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### LIMITATIONS

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The purpose of this review was to critically evaluate and synthesise findings from the existing research literature comparing physical characteristics and physical performance capacities of part-time and full-time tactical personnel. While the literature search was exhaustive, the identified studies were only of moderate quality and very limited in number, with only six articles identified for inclusion<sup>11-16</sup>. In addition, only articles that were available in English were included and this may have introduced a language bias. Caution should therefore be exercised in interpretation of the findings of the review and in the application of these findings in practice. Further high quality research on these issues is needed.

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### CONCLUSION

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Acknowledging that there was limited research of moderate quality, the available evidence indicates that typically part-time personnel exhibit higher BMI and body-fat levels and lower levels of aerobic capacity and strength than full-time personnel. However, findings regarding aerobic

capacity and strength are variable and may reflect variation across populations in differences between part-time and full-time personnel in regular work frequencies and intensities, and individually and institutionally-arranged physical training regimes. In addition, the review has revealed that access to ‘on-duty’ physical training sessions is much more limited for part-time personnel than for full-time personnel, and this may account for some of the observed differences in physical characteristics and physical performance capacities. These physical differences, in turn, are likely to place part-time tactical personnel at greater risk of injury and reduce their effectiveness in their job roles, when compared to their full-time counterparts. Given the moderate methodological quality and low quantity of available research in this area, caution should be applied in the interpretation and application of these findings to practice. Further high quality research is needed.

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## CHAPTER 2 - A COMPARISON OF WORK HEALTH AND SAFETY INCIDENTS AND INJURIES IN PART-TIME AND FULL-TIME AUSTRALIAN ARMY PERSONNEL

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### PREFACE

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Part-time personnel are an integral part of the Australian Army. With their operational deployments increasing, identification and optimal management of their work health and safety risks is critical. The objective of the research reported in this chapter was to compare the patterns of reported work health and safety incidents and injuries in part-time and full-time Australian Army personnel. This information is intended for commanders, clinicians, safety officers and conditioning coaches to ensure training is optimised and other sources of risk are well managed for the highlighted high risk activities.

The paper incorporated in this chapter has been accepted for publication in the *Journal of Athletic Training*, with approval for publication provided by the Directorate of Health Research, Joint Health Command (150706).

McDonald, D. Pope, R. & Orr, R. (2015). A Comparison of Work Health and Safety Incidents and Injuries in Part-time and Full-time Australian Army Personnel, *Journal of Athletic Training*.

This research paper was also presented at the Australasian Military Medicine Association Conference in Hobart, Australia, 09-11 October 2015 with approval from the Directorate of Health Research, Joint Health Command (150707).

Orr, R., Pope, R. & McDonald, D., (2015). A Comparison of Work Health and Safety Incidents and Injuries in Part-time and Full-time Australian Army Personnel. Podium presentation at the Australasian Military Medicine Association Conference, Hobart, Australia, 09-11 October 2015

The abstract from the conference presentation was published in the *Journal of Military and Veteran's Health*, 23(4), pp. 22-23.

The PowerPoint presentation associated with that presentation, given on 09 October 2015, can be found in Appendix 2.

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## A COMPARISON OF WORK HEALTH AND SAFETY INCIDENTS AND INJURIES IN PART-TIME AND FULL-TIME AUSTRALIAN ARMY PERSONNEL

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### INTRODUCTION

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Work health and safety incidents (which can include injuries or dangerous occurrences that did not cause an injury) are of great concern to the Australian Army. Injuries, defined as instances where physical harm to the body has been formally reported, interrupts participation of personnel in active duty service, and also affects the readiness and productivity of the Australian Defence Force <sup>1</sup>. Like many military forces around the world, the Australian Army is comprised of both part-time and full-time personnel, with work health and safety incidents and resulting injuries affecting both populations <sup>1,2</sup>. However, unlike full-time regular soldiers, part-time soldiers (or ‘reservists’) typically have primary employment outside the military and only become full-time soldiers when called upon to participate in training exercises and local or international military operations <sup>3</sup>. Of note, with active service of this nature becoming increasingly more frequent in recent years, these part-time personnel are no longer considered to be ‘back up’ personnel, but rather to be integral to the successful functioning of the full-time forces <sup>4</sup>.

With operational deployments increasing <sup>4,5</sup>, part-time soldiers now contribute to around 10% of Australian <sup>4</sup> and United Kingdom forces <sup>6</sup>. In the United States, reservists make up approximately half of personnel actually fighting the current conflicts <sup>7</sup>. Strategically, the Australian Defence Force Defence White Paper <sup>1</sup> has acknowledged the importance of integrating Australian Army Reserve and Australian Regular Army personnel under the government approved plan, *BEERSHEBA*. For this reason, the ability of army reserve personnel to effectively work and keep pace with their regular army peers, without experiencing excessive numbers of work health and safety incidents or injuries, is vital <sup>1</sup>. Despite the importance of this Reserve capability, preliminary research conducted by the Australian Department of Defence in 2000 <sup>2</sup>, based on limited data, suggested that part-time Australian Defence Force personnel were three times more likely to report injuries that had occurred during physical and military training than full-time personnel, when actual days of exposure to military service were considered. Data specific to army reserve

personnel was not available in that report, but a similar trend in army reserve personnel is expected to that observed in the Australian Defence Force as a whole, since Army was the largest of the services within the Australian Defence Force. No other paper has been identified which compares injury rates in full-time and part-time Australian Defence Force personnel.

There are several potential factors that could contribute to an increased risk of army reserve personnel experiencing work health and safety incidents or injuries. These include: (1) the requirement to complete the same physical fitness assessments and participate in the same field exercises as their regular army peers at a commensurate level;<sup>1,3</sup> (2) deployment on the same combat operations, and in the same roles, as regular army personnel;<sup>1</sup> (3) need to balance other occupations and work demands; (4) being responsible for their own individualised training sessions, with on-the-job physical training at a lower level than that for full-time personnel;<sup>3,8,9</sup> and (5) having less contact with army physical training instructors and clinicians than full-time personnel, and so less monitoring and management of their injury risks both as individuals and as a population.

Due to their typically shorter, intermittent bouts of active service, army reserve personnel tend not to experience the same amount of chronic military physical conditioning as regular army personnel. With previous research showing a strong link between the level of physical conditioning and injury risk<sup>10</sup>, these differences in levels of specific conditioning, when considered against the requirement to perform tasks at the same level as full-time personnel, are likely to increase rates of work health and safety incidents and injuries among army reserve personnel when they undertake military duties. Compounding this problem, and in contrast to full-time personnel, part-time army personnel often have their injuries managed by clinicians who are external to the military organisation and therefore less familiar with the particular military context and current demands than clinicians embedded within the organisation. Part-time personnel also generally have less contact with army physical training instructors. In the Australian Army context, both clinicians and physical training instructors play an important collaborative role in conjunction with safety officers in monitoring, detecting and managing the sources of risk associated with emerging injury trends and clusters, and informing training design to prevent injuries<sup>11,12</sup>. These important risk management activities are

therefore frequently lacking for army reserve personnel, and this gap is likely to further increase rates of work health and safety incidents and injuries among army reserve personnel.

Research, internationally, comparing part-time and full-time army populations has focused on differences in training regimes and their effects <sup>3</sup>, as well as the ability to complete common military tasks <sup>9</sup>. In contrast, research in this field within the Australian Army has still been largely focused on full-time personnel and the means to successfully reduce their injury rates <sup>11,12</sup>. Given the preliminary evidence of increased injury rates in Reserve personnel provided by the Defence Health Status Report <sup>2</sup>, albeit based on limited data, and recent increases in army reserve deployment requirements, it is imperative that we begin to investigate the patterns of reported work health and safety incidents and resulting injuries among part-time Army personnel and compare them to the patterns observed in full-time personnel. Once we understand these patterns of work health and safety incidents and injuries in part-time Army personnel, strategies can be developed to prevent and manage the associated risks.

The aim of this research project was therefore to: (a) determine the proportions of reported work health and safety incidents that resulted in injuries in the army reserve and regular army populations within the period of interest; and (b) to quantify and compare between army reserve and regular army population's key factors involved in work health and safety incidents.

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## METHODS

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A retrospective cohort study was conducted to ascertain and compare the work health and safety incident profiles of army reserve and regular army personnel based on incident and personnel data obtained for these populations in the period 01 July 2012 to 30 June 2014, inclusive. Work health and safety incident and injury data were sourced from the Workplace Health, Safety, Compensation and Reporting (WHSCAR) database of the Australian Department of Defence, which constitutes the source of records of incidents and injuries sustained by army personnel. The WHSCAR database is designed to capture all incident reports submitted in the notification and reporting of Workplace Health and Safety incidents occurring within the Department of Defence <sup>13</sup>. A qualified WHSCAR

database operator extracted the data from the database in order to maintain record privacy and ensure optimal data retrieval.

The WHSCAR data set provided to the researchers included Service (Army) and service type (part-time or full-time) to which the affected person belonged, type of occurrence, date of incident, incident status, incident severity, nature of resulting injury, body site affected by resulting injury, mechanism of resulting injury, activity at the time of the incident (including specific event, e.g. field exercise, if applicable), incident description, and duty status at the time of the incident. The mean population sizes of army reserve and regular army personnel across the study period were sourced from published Department of Defence Records (See Table 3) <sup>14,15</sup>.

TABLE 3: ARMY RESERVE (ARES) AND AUSTRALIAN REGULAR ARMY (ARA) SOLDIER POPULATION SIZES 2012-2014

	<b>ARES</b>	<b>ARA</b>	<b>Whole of Army</b>
<b>2012 - 2013</b>	14867	28955	43822
<b>2013 – 2014</b>	15200	29847	45047
<b>Mean Total</b>	15034	29401	44435

Work health and safety incident and injury records extracted from the WHSCAR database were included in the study data set if they related to: (a) Australian Army Reserve or Australian Regular Army personnel; (b) an incident or injury that occurred while the person was ‘on duty’; and (c) an incident or injury that occurred between 01 July 2012 and 30 June 2014, inclusive. Records were excluded if they: (a) related to personnel from Australian military services other than the Australian Army; (b) related to personnel from a foreign defence service, on secondment; or (c) contained missing or incomplete data.

All work health and safety incident and injury records were grouped according to the service type (army reserve or regular army) and formed the primary basis for comparative analyses. The primary outcome measure comprised the proportion of reported work health and safety incidents that resulted in injuries, in the army reserve and regular army populations. Secondary outcome measures

comprised proportional representations of specific: (a) body locations affected by incidents; (b) natures of resulting injuries; (c) injury mechanisms; and (d) activities being performed at the times incidents occurred. Each outcome measure was calculated as the percentage of work health and safety incidents that included a particular response option.

The Australian Defence Human Research Ethics Committee (ADHREC) and the Bond University Human Research Ethics Committee (BUHREC) granted ethics approval for this study. Departmental authorisation for the project was obtained in parallel to the process for obtaining ADHREC approval.

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#### DATA ANALYSIS

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The WHSCAR database operator provided us with raw, non-identifiable data in a Microsoft Excel spread sheet. This data was then manually cleaned to ensure that only the records consistent with the inclusion and exclusion criteria were retained. In addition, each line of data was reviewed and compared to other lines of data to ensure identification and removal of duplicate entries (i.e. same record entered twice). Each data record was further verified, corrected or made more precise by manually comparing the allocated Type of Occurrence Classification System (TOOCS) classifications with the free text narrative data from the same record. When discrepancies were identified, precedence was given to the free text narratives and the TOOCS classification was adjusted accordingly, as narratives provided by incident reporters are considered more detailed and accurate than data entered by a third party using a finite coding system <sup>16</sup>. The resulting, often more precise, TOOCS codes were employed in the subsequent data analysis.

Data were entered into the Statistical Package for the Social Sciences (SPSS: IBM, USA) Version 21.0 for statistical analysis. Descriptive analyses were employed to examine and describe the data and to calculate the primary and secondary outcome measures (described above) for army reserve and regular army populations in each year of the period of interest.

For the purposes of our study, our definition of *work health and safety incidents* included all incidents recorded on the WHSCAR database for the population and period of interest, comprising:

(a) minor personal injuries (MPI); (b) serious personal injuries or illness; (c) dangerous occurrences; (d) fatalities; (e) incidents involving exposure to a hazardous substance or material; and (f) ‘near misses’. For the purpose of this study, our definition of *injury* included only the following types of incident reported on the WHSCAR database: (a) minor personal injuries; and (b) serious personal injuries or illness <sup>13</sup>.

## RESULTS

In total, 15065 work health and safety incidents were reported (2012-2013, n=7633; 2013-2014, n=7432). Among these, 11263 injuries (comprised of MPI and Serious Personal Injuries and Illness) were reported across the two-year study period and the numbers of injuries reported in army reserve and regular army populations, in each year of the study period, are detailed in

Table 4. Given that the population figures for army reserve and regular army (Table 3) were relatively stable year-to-year, the figures presented in

Table 4 indicate that the reported injury incidence rates were relatively stable in army reserve and in regular army populations, year-to-year.

TABLE 4: REPORTED INJURIES BY YEAR AND SERVICE TYPE

		<b>ARES</b>	<b>ARA</b>	<b>Whole of Army</b>
<b>2012-2013</b>	<b>Injuries</b>	708	4775	5483
	<b>% within year</b>	13	87	100
<b>2013-2014</b>	<b>Injuries</b>	726	5054	5780
	<b>% within year</b>	13	87	100
<b>Total 2012-2014</b>	<b>Injuries</b>	1434	9829	11263
	<b>% within years</b>	13	87	100

Note. Percentages rounded to the nearest whole percent.

Since the frequencies of reported work health and safety incidents and underlying army reserve and regular army population sizes were each relatively stable across the two study years, all of the results presented below represent aggregated work health and safety incident data, pooled across the full two-year study period. It is important to note that some of reported work health and safety

incidents (exposure to a chemical substance for example) did not result in a reported injury, and this fact is reflected in the findings presented below.

In the army reserve population, 85% of reported incidents were classified as involving minor personal injuries, with a further 4% involving a serious personal injury. In the regular army population, 68% of reported incidence involved a minor personal injury and 5% involved a serious personal injury. In each of the army reserve and regular army populations, we calculated a fatality rate of one fatality per 1000 reported work health and safety incidents. The remaining incidents in army reserve and regular army populations did not involve an injury, but rather constituted ‘near misses’, ‘dangerous occurrences’ or ‘exposures to hazards’.

The proportions of reported work health and safety incidents in army reserve, regular army and total Army populations that involved specific reported body locations in the affected personnel are presented in

Table 5. The raw data relating to reported body locations comprised 36 different body location categories, and these were grouped to form the seven overarching categories listed in

Table 5. Many of the reported work health and safety incidents for which ‘Other’ is noted as the affected body location were incidents such as exposures, near misses and dangerous occurrences, in which no injury was sustained and so no specific body location could be reported.

TABLE 5: BODY LOCATIONS AFFECTED BY REPORTED WHS INCIDENTS, BY SERVICE TYPE.

Body location	ARES	ARA	Whole of Army
Lower limb	36.50%	30.80%	31.40%
Trunk and Pelvis	23.40%	21.20%	21.40%
Upper limb	14.60%	9.50%	10.00%
Systemic	10.60%	22.80%	21.50%
Head	8.30%	7.80%	7.90%
Other	6.60%	7.90%	7.80%
Total	100.00%	100.00%	100.00%



The proportions of reported work health and safety incidents in army reserve, regular army and total Army populations that involved an injury of a particular nature are presented in Table 4. The raw data relating to the natures of injuries sustained from reported work health and safety incidents comprised 117 different nature of injury categories, and these were grouped to form the 17 overarching categories listed in Table 6.

TABLE 6: NATURE OF INJURIES RESULTING FROM REPORTED WHS INCIDENTS, BY SERVICE TYPE.

Nature of injury	ARES	ARA	Whole of Army
Harm to unspecified soft tissues	42.9%	32.3%	33.5%
Harm to muscles and tendons	14.2%	11.2%	11.5%
Disease or chronic condition	7.0%	4.3%	4.6%
Harm to joints and ligaments	4.9%	7.5%	7.2%
Laceration or open wound (not amputation)	4.7%	3.9%	4.0%
Burns	2.6%	1.0%	1.2%
Harm to bones	2.5%	5.0%	4.7%
Poisoning and toxic effects of substances	2.3%	0.9%	1.0%
Superficial injury	2.3%	0.8%	0.9%
Foreign body on external eye, or in ear, nose, or respiratory, digestive or reproductive tract	1.9%	0.9%	0.9%
Heat stress/heat stroke	1.9%	1.7%	1.7%
Deafness	0.8%	2.0%	1.9%
Intracranial injury	0.8%	1.2%	1.2%
Harm to mental health	0.4%	1.1%	1.0%
Other specified injury	1.5%	1.5%	1.6%
No known injury resulted from incident	9.3%	24.7%	23.1%
Total	100.0%	100.0%	100.0%

The proportions of reported work health and safety incidents in army reserve, regular army and total Army populations that involved particular mechanisms of injury are presented in

Table 7. The raw data relating to the mechanisms of injuries sustained from reported work health and safety incidents comprised 41 different mechanism of injury categories. Of these categories, those representing mechanisms of injury which were associated with more than 1% of work health and safety incidents in either army reserve or regular army populations are listed in

Table 7 and then the many mechanisms of injury which were associated with less than 1% of work health and safety incidents in both army reserve and regular army populations are grouped under the ‘Other’ category.

TABLE 7: MECHANISMS OF INJURIES RESULTING FROM REPORTED WHS INCIDENTS, BY SERVICE TYPE.

<b>Mechanism of injury</b>	<b>ARES</b>	<b>ARA</b>	<b>Whole of Army</b>
<b>Muscular stress while lifting, carrying or donning equipment</b>	34.8%	31.6%	31.9%
<b>Fall</b>	20.2%	14.9%	15.5%
<b>Contact with moving or stationary object</b>	12.1%	10.3%	10.4%
<b>Chemical substance</b>	5.5%	18.1%	16.8%
<b>Vehicle accident</b>	3.0%	3.3%	3.3%
<b>Insect and spider bites and stings</b>	2.3%	0.5%	0.6%
<b>Contact with, or exposure to, biological factors of unknown origin</b>	2.1%	2.3%	2.3%
<b>Contact with hot objects</b>	1.9%	0.4%	0.5%
<b>Exposure to environmental heat</b>	1.9%	1.6%	1.7%
<b>Rubbing and chafing</b>	1.1%	0.5%	0.6%
<b>Long term exposure to sounds</b>	0.2%	1.6%	1.4%
<b>Other and multiple mechanisms of injury</b>	13.8%	13.8%	13.8%
<b>Unspecified mechanisms of injury</b>	1.1%	1.1%	1.2%
<b>Total</b>	100.0%	100.0%	100.0%

The proportions of reported work health and safety incidents in army reserve, regular army and total Army populations that occurred during particular activities are presented in Table 8. The raw data relating to the activities during which reported work health and safety incidents occurred comprised

72 different activity categories. Of these categories, those representing activities which were associated with more than 1% of work health and safety incidents in either army reserve or regular army populations are listed in Table 6 and then the many activities which were associated with less than 1% of work health and safety incidents in both army reserve and regular army populations are grouped under the 'Other' category.

TABLE 8: ACTIVITIES DURING WHICH REPORTED WHS INCIDENTS OCCURRED, BY SERVICE TYPE.

Activity	ARES	ARA	Whole of Army
<b>Combat training</b>	23.6%	12.0%	13.3%
<b>Physical Training</b>	20.2%	24.6%	24.1%
<b>Manual/Materials handling</b>	8.5%	4.7%	5.1%
<b>Patrolling</b>	6.0%	1.8%	2.2%
<b>Marching</b>	5.7%	4.0%	4.2%
<b>Weapon Handling Total</b>	5.5%	3.8%	4.0%
<b>Walking</b>	5.1%	2.9%	3.1%
<b>Driving</b>	2.8%	2.1%	2.1%
<b>Sports Total</b>	2.5%	8.9%	8.2%
<b>Passenger in Vehicle</b>	2.3%	1.0%	1.1%
<b>Sleeping</b>	1.5%	0.3%	0.4%
<b>Boarding/Alighting a Vehicle</b>	1.3%	0.6%	0.6%
<b>Office Work Total</b>	1.1%	1.0%	1.0%
<b>Vehicle maintenance</b>	0.9%	1.6%	1.5%
<b>Operational</b>	0.9%	18.8%	16.9%
<b>Other</b>	7.4%	8.5%	8.4%
<b>Unknown</b>	4.7%	3.4%	3.8%
<b>Total</b>	100.0%	100.0%	100.0%

## DISCUSSION

The aim of our research was to: (a) determine the proportions of reported work health and safety incidents that resulted in injuries in the army reserve and regular army populations, within the period of interest; and (b) to quantify and compare between army reserve and regular army

population's key factors involved in work health and safety incidents. Such information can be used by commanders, athletic trainers, other clinicians, physical training instructors and safety personnel to identify key injury risks and their sources and to inform injury risk management approaches<sup>11,12</sup> for either or both populations, depending on the respective needs this information reveals, but the focus of this paper is army reserve personnel.

In the army reserve population, 85% of reported incidents were classified as involving minor personal injuries, with a further 4% involving a serious personal injury. In the regular army, a slightly lower proportion (68%) of reported incidents involved a minor personal injury, while a similar 5% involved a serious personal injury.

The key features of work health and safety incidents were similar between the populations when we considered the top five categories for: (a) body locations, (b) natures of injury, (c) and mechanisms of injury. While similarities were again evident, some differences were observed between army reserve and regular army populations in the activities being undertaken at the times the work health and safety incidents occurred.

For both army reserve and regular army personnel, the lower limbs were the leading body location affected by incidents, with the proportion of reported incidents involving the lower limbs being slightly higher in the army reserve population when compared to the regular army population. This finding of lower limbs being the leading body location is not unexpected given that the lower limbs in particular have been previously found to be the leading body location of injury in military personnel<sup>17,18</sup> and have, in some instances, been the body location attributed with suffering over 80% of reported injuries in military personnel<sup>17</sup>. It is of note that the proportion of work health and safety incidents that involved lower limb injuries across Army as a whole in this study (31.4%) is strikingly similar to the proportion reported in the Australian Defence Health Status report in 2000<sup>2</sup> for the whole of the Australian Defence Force (31.5%), suggesting little variation in the distributions of injuries across body sites over the last 15 years.

Apart from a high proportion of reported injuries being systemic injuries in the regular army (22.8%), the next most commonly-injured body location for both groups was the trunk (army reserve=23.4%: regular army 21.2%) followed by the upper limbs (army reserve=14.6%: regular army 9.5%). This result differs from the findings in the Australian Defence Health Status report in 2000 (2), which found the upper limbs to be the next most commonly reported body location of injury in the Australian Defence Force as a whole (21.7%), followed by the trunk (14.8%). One potential reason for this increase in the proportion of injuries that were trunk presentations may be the increased use of body armour and the increased carriage of heavy loads. Wearing body armour has been found to increase the physical demands of performing a given task <sup>19</sup> and as such it is not unexpected that it is associated with causing back injuries in military populations <sup>20</sup>. This hypothesis is supported by research showing the lower limbs followed by the trunk to be the leading body locations of injury during or following load carriage events <sup>21,22</sup>.

Soft tissue structures were the most commonly reported nature of injuries reported for both army reserve and regular army. The proportion of total injuries these injuries constituted was again higher in the army reserve when compared to regular army (

Table 4). The most common mechanism of injury for both populations was muscular stress while lifting, carrying or donning equipment, followed by falling. Again the proportion of reported work health and safety incidents that injuries with this mechanism constituted in army reserve personnel was slightly higher than in regular army personnel (55% and 46.5% of reported work health and safety incidents, respectively). While other occupational factors may exist, like the nature of corps requirements (e.g. lifting artillery shells), one common task that both populations would be exposed to regardless of corps is load carriage.

Muscular stress from lifting, carrying and donning equipment and falling over have been found to be a leading mechanisms of injury within this population while carrying heavy loads <sup>21</sup>. While the association between load carriage and injuries that occur while lifting, carrying and donning equipment can be clearly seen, the direct link between load carriage and an increased risk of falling may be less apparent. Previous studies <sup>23,24</sup> have found that the numbers of participants able to successfully negotiate individual obstacles decreased as the load weight carried increased. In one

study of interest, loads of 9.1 kg led to 42 % (10 of 24) of participants making contact with a 30 cm obstacle while stepping over it <sup>24</sup>. As such, with soldiers carrying loads of over 40 kg <sup>25,26</sup>, their potential to trip and fall while performing tasks is increased considerably by the loads they carry. The reduced amount of chronic conditioning for army reserve personnel <sup>3,8,9</sup> given their requirements to carry loads commensurate with their full-time counterparts<sup>3</sup> may have led to the higher proportion of falls mechanisms in injuries arising from work health and safety incidents in the army reserve population.

Although slightly lower in the army reserve population, both groups had similar percentages of injuries attributed to physical training. While physical training and sport have previously been identified as leading causes of injury in military populations,<sup>2</sup> this finding was unexpected as lower levels of fitness (which have been identified in other tactical populations to be more common in part-time personnel <sup>27</sup>) have been associated with an increased risk of injury <sup>10</sup>. As such, a higher percentage of physical training injuries in army reserve soldiers was expected. A notable difference did exist in the lower percentage of sporting injuries among army reserve personnel when compared to regular army personnel (2.5% versus 8.9%). These lower percentages of reported sports-related work health and safety incidents are understandable given that army reserve personnel may be less exposed to sport while considered 'on duty'.

Combat tasks and manual handling were other activities for which differences between the two populations existed. In the army reserve population, combat tasks, which include both combat training and patrolling specifically, represented more than twice the work health and safety incidents (29.6%) represented in the regular army population (13.8%). Manual handling, which can also be associated with combat tasks (picking up and carrying combat stores, wounded personnel, etc.) also accounted for a substantially higher proportion of work health and safety incidents in army reserve than regular army personnel. A potential reason for this difference can be training differences between the two populations with Reserve training predominantly being performed outside of military duties <sup>28</sup>. As such, with less exposure to combat and supervised physical training, army reserve personnel can be at a higher risk of injury when required to perform these combat tasks at levels required of regular army personnel. Furthermore, the reduced exposure alone may expose army reserve personnel to an increased injury risk when recommencing these combat tasks <sup>29</sup>.

In our study, army reserve personnel reported a higher percentage of injuries to be associated with manual handling activities (8.5% versus 4.7% respectively) than regular army personnel. Military personnel are often required to manually handle heavy materials<sup>9</sup>. Williams and Evans<sup>9</sup>, when profiling the manual handling heavy loads in the British Army, found no significant differences in manual handling ability between Reserve soldiers and regular army soldiers. Based on this finding, we expected to see similar proportions of reported incidents representing manual handling incidents among army reserve and regular army personnel, but this was not the case. Whilst the observed differences in the current study may be an artefact of data limitations, it is again possible that army reserve personnel struggle to achieve the chronic load carriage conditioning attained by regular army personnel and this may account for the observed increases in their proportions of work health and safety incidents and injuries that arise from manual handling, as it does with combat related tasks.

A key limitation of this research was the reliance on retrospective data capture via a formal reporting system. This limitation means that there was the potential for more minor injuries (like blistering, mild ankle sprains, etc.) to go unreported. This data limitation may suggest the potential for our research to under report actual injuries occurring in the workplace.

When the body locations, natures of injury, mechanisms and activities associated with reported injuries are considered collectively, an interesting pattern emerges. While similar in rankings of body locations of injuries, in some instances army reserve personnel reportedly suffer a higher percentage than regular army personnel of injuries being to the lower limbs, with soft tissue, muscles and tendons the most common structures affected by the injury. These injuries more commonly occur during combat training, with muscular stress while lifting, carrying or donning equipment and falling being the most common mechanism. When the reduced chronic conditioning, training time and military styled training undertaken by army reserve personnel are considered, these differences are understandable.

These findings provide valuable guidance for commanders, athletic trainers, other clinicians, physical training instructors and safety personnel, as they seek to identify key injury risks and their sources and manage injury risks in army reserve personnel. The findings suggest that priorities for injury risk management in army reserve personnel should be combat training, patrolling and manual handling, and particularly mechanisms of injury involving lifting, donning and carrying equipment, and falling. Optimisation of physical preparedness to undertake these tasks without injury is likely to be one important element of any injury risk management approach for army reserve personnel, based on the patterns of injury identified in this study and existing knowledge of causes of injuries of the identified types in the contexts of the identified key activities and mechanisms. However, it will also be important to examine the potential contributions of task and environmental design<sup>11,12</sup>, particularly where the tasks undertaken are for training purposes, meaning that task and environmental designs can likely be controlled and optimally progressed to match training stage and trainee skill levels to a much greater extent than in operational contexts. Collaboratively, commanders, athletic trainers, other clinicians, physical training instructors and safety personnel are well-placed to review and ensure optimal training design and to conduct investigations of the potential contributions of task design and environment in order to develop appropriate and effective risk management approaches<sup>11,12</sup>.

While it is recognised that it would be optimal for reserve personnel to be exposed to the same conditioning practices as full-time personnel, the nature of part-time service limits this potential. Considering this, this research suggests that there is little difference between full-time and reserve personnel in proportions of injuries sustained during physical training while there are notable differences in proportions of injuries sustained during combat training, patrolling and manual handling.

One potential reason for these differences may be a lack in specificity of the physical training undertaken by reserve personnel. For example, reserve personnel may run or train in a gymnasium, doing resistance training or group exercises, and as such have a good general fitness, however it is less likely that they would engage in combat orientated fitness that involves load carriage and the manual handling (lift and carry) of heavy stores. The importance of this specific conditioning cannot be underestimated. Based on previous literature, load carriage conditioning for military personnel should preferably occur on a weekly basis.<sup>30</sup> With the potential for reserve personnel only



to attend military exercises monthly or even yearly, this conditioning would be required to be conducted outside of formal military training.

Given that wearing of actual combat loads in public places without broad-based forewarning of the general public regarding the purpose of the military exercise would not be acceptable, the athletic trainer, physical training instructor and other key advisors could steer sessions towards those that involve alternative, less publicly-alarming forms of load carriage, like orienteering, rogaining and hiking. Likewise an emphasis should not only be placed on lifting loads but also on carrying them. As such, activities like a farmer's carry could be incorporated into a session. Finally, the overall training provided would still need to include elements of metabolic (aerobic) fitness and muscular strength, power and endurance, which are not only for injury prevention but optimal task performance<sup>31,32</sup>.

If physical training sessions are to be integrated, including both full-time and part-time personnel, the physical training instructor, athletic trainer and other key advisors would need to be cognisant of the fact that while both groups may present with similar levels of fitness during general physical training activities, the reserve personnel may be less conditioned than the full-time personnel for combat orientated training. To facilitate training while considering this conditioning difference, reserve personnel may initially need to carry a lighter load than full-time personnel during a combat conditioning session and be provided with a more gradual increase in load to account for the potential lack of chronic combat orientated conditioning.

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## **CHAPTER 3 - INCIDENCE RATES FOR WORK HEALTH AND SAFETY INCIDENTS AND INJURIES IN AUSTRALIAN ARMY RESERVE VS FULL-TIME SOLDIERS, AND A COMPARISON OF REPORTING SYSTEMS**

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### **PREFACE**

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Work health and safety (WHS) incidents and associated injuries affect capabilities of both Australian Army Reserve (ARES) and Australian Regular Army (ARA) personnel but rates are rarely reported for reservists. The aim of the research reported in this chapter was to determine incidence rates of reported WHS incidents and injuries in ARES and ARA personnel and assess the relative performance of WHS incident reporting systems. The difference in incidence rates, when adjusted for years of active service, was calculated and is provided along with recommendations for future injury reporting.

Ethics approval for this research project was obtained from the Australian Defence Human Research Ethics Committee (LERP14-024) and the Bond University Human Research Ethics Committee (RO1907).

The research paper included as part of this chapter has been submitted for publication in the Australian and New Zealand Journal of Public Health, with approval for publication being sought from the Directorate of Health Research, Joint Health Command.

This research paper was also presented at the Australasian Military Medicine Association Conference in Hobart, Australia, 09-11 October 2015 with approval from the Directorate of Health Research, Joint Health Command (150707).

Pope, R., McDonald, D. & Orr, R. (2015). Incidence rates of reported work health and safety incidents and injuries in part-time and full-time Australian Army personnel. Podium presentation at the Australasian Military Medicine Association Conference, Hobart, Australia, 09-11 October 2015.

The abstract from the conference presentation was published in the Journal of Military and Veteran's Health, 23(4), pp 45-46.

The PowerPoint presentation associated with that presentation, given on 09 October 2015, can be found in Appendix 3.

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## INCIDENCE RATES FOR WORK HEALTH AND SAFETY INCIDENTS AND INJURIES IN AUSTRALIAN ARMY RESERVE VS FULL-TIME SOLDIERS, AND A COMPARISON OF REPORTING SYSTEMS

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### INTRODUCTION

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Reserve soldiers constitute a substantial and integral part of contemporary military forces and, just like their full-time counterparts, their capabilities can be rapidly degraded by work health and safety (WHS) incidents and associated injuries. Despite these facts, rates and sources of WHS incidents and injuries are rarely reported for reservists, and this knowledge deficit limits the information commanders have at their disposal when seeking to manage associated risks. These risks affect not only the individual, and potentially their civilian workplace, but also the military teams in which they operate and operational capability.

In order to begin to address this knowledge deficit, in a recent study <sup>1</sup> we examined WHS incident and injury rates and patterns in Australian Army Reserve (ARES) soldiers and compared them to those in full-time soldiers in the Australian Regular Army (ARA). We found that, *per capita*, ARES soldiers reported fewer WHS incidents and injuries than their ARA counterparts in a recent two-year period, and we identified some key sources of injuries in both ARES and ARA populations. However, we also noted that the *per capita* incidence rates calculated in that study did not take into account the fewer annual days of active service typically served by ARES soldiers, for which the numbers were not available at the time of that study. We therefore recommended that future research be conducted to compare the incidence rates of WHS incidents and injuries in ARES and ARA soldiers, in terms of the numbers of incidents and injuries reported per 100 person-years (or

full-time equivalent years) of active service, so that the relative level of exposure to military service was taken into account.

To date, only one other identified publication<sup>2</sup> has compared the reported injury incidence rates for military reserve and full-time personnel. That publication, the Australian Defence Force (ADF) Health Status report published in 2000,<sup>2</sup> noted that ADF reserve personnel reported more than 3 times the rate of injuries reported by their full-time ADF counterparts for each full-time equivalent year of active service. While the full-time personnel reported 9 injury or illness incidents for every 100 soldiers, the reserve personnel reported 29 such incidents for every 100 full-time equivalent years of active service. This was notably quite different to the *per capita* rate of 4 incidents for every 100 reserve personnel, first presented in the Defence Health Status report,<sup>2</sup> which initially suggested that full-time personnel suffered a higher rate of injuries and illness when the much lower annual days of active service typical of reserve personnel were not taken into account.

One difficulty in ascertaining both *per capita* incidence rates and incidence rates that take into account the level of exposure is the often unknown threshold for reporting of WHS incidents and injuries. In other words, what proportions of incidents and injuries that occur are actually reported? For example, it may be that only certain injuries are reported (e.g. a fracture as opposed to a blister) or that only some people routinely report their injuries. When presented with comparative rates of reported WHS incidents and injuries for different cohorts, the concern is always therefore whether any differences in reported rates represent real differences between the cohorts in actual incident and injury rates or whether the differences are simply an artefact of different reporting thresholds in the cohorts being compared. Of relevance to the current study, ARES personnel (unlike ARA

personnel) are not entitled to ongoing free medical care from the ADF and this may provide a significant additional incentive for them to report injuries they experience, as an injury report is usually a key piece of evidence for any worker's compensation claim they may wish to make to cover medical costs they subsequently incur. This being the case, we might expect higher rates of reporting by ARES personnel than by ARA personnel, even if injury rates are similar, in any equivalent number of days of active service.

In addition, thresholds for reporting of WHS incidents and injuries are important because if the threshold is too high and injuries are rarely reported, the volume and quality of data available to guide injury risk management efforts is markedly reduced. Furthermore, rates of injuries sustained may appear to be minimal whereas in fact injury rates could be markedly higher. This data deficit impacts negatively on the statistical power of any analysis of the data to identify emerging risks or spikes in injury rates in a timely manner, with flow-on effects to command capacity to manage the associated risks and thereby maintain Army capability. If 'near misses', 'dangerous occurrences' and 'minor injuries' are not routinely reported, then new or emerging hazards and sources of injury risk can also be easily missed, with similar flow-on effects. WHS incident and injury reporting rates therefore constitute a key indicator of WHS incident reporting system utility for commanders. Other indicators of utility include: <sup>3</sup> having efficient, routine and multi-purpose incident reporting mechanisms; ensuring the system has adequate and suitably tailored and timely information outputs; system capability for timely detection and command alerts regarding emerging incident trends of importance; and ensuring there is a robust feedback loop to those reporting and entering data in order to maintain their commitment to ensuring data integrity.



On this basis, the aim of this study, which drew in part on the same data set used in our other recent paper on this topic and comprised an extension to that previous study, was two-fold: (a) to determine the recent incidence rates of reported work health and safety (WHS) incidents and injuries in ARES and ARA personnel; and (b) to assess the performance of the Australian Department of Defence WHSCAR system relative to other injury incident reporting systems, with regard to injury incident capture rates.

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## METHODS

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### RESEARCH DESIGN

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A retrospective cohort study was conducted to ascertain and compare the incidence rates of both WHS incidents and injuries for the complete ARES and ARA populations in the period 1 July 2012 to 30 June 2014, inclusive. The injury incidence rates derived from the data sources used in this study were subsequently compared to injury incidence rates from previously published Army injury reports which used other systems of data capture, to assess differences in injury incident capture rates.

### ETHICS APPROVAL

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Ethics approval for the study was granted by the Australian Defence Human Research Ethics Committee (ADHREC; protocol LERP 14-024) and the ##### University Human Research Ethics Committee (XXXHREC; protocol RO1907). Authorisation to conduct the project was also obtained from the Australian Department of Defence and authorisation to release this paper from Joint Health Command.

### WHS INCIDENT AND INJURY DEFINITIONS

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For the purposes of this study, the definition of *WHS incidents* included all incidents recorded on the WHSCAR database for the population and period of interest, comprising: (a) minor personal injuries; (b) serious personal injuries (or illness); (c) dangerous occurrences; (d) fatalities; (e)

incidents involving exposure to a hazardous substance or material; and (f) ‘near misses’. The definition of *injury* included only the following types of incident reported on the WHSCAR database: (a) minor personal injuries; and (b) serious personal injuries (or illness).

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#### DATA SOURCES

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WHS incident and injury data and population data for both ARES and ARA were obtained for the period 01 July 2012 to 30 June 2014. The WHS incident and injury data were extracted and provided in a non-identifiable form by an administrator of the Workplace Health, Safety, Compensation and Reporting (WHSCAR) database of the Australian Department of Defence.

The WHSCAR database is designed to record all incident reports submitted in the notification and reporting of Workplace Health and Safety incidents that have occurred in the Department of Defence.<sup>4</sup> The data set extracted from the WHSCAR database confirmed, for each incident record, that the affected individual’s Service was Army. It also identified their serving status (part-time or full-time) and the type of occurrence, date of incident, incident status, incident severity, nature of incident, body site affected by incident, mechanism of incident, activity at the time of incident (including specific event, e.g. field exercise, if applicable), incident description, and duty status (on or off duty) at the time of the incident. The mean population sizes for ARES and ARA, across the study period, were derived from published reports of the Department of Defence.<sup>5,6</sup> The total number of days of active service undertaken by ARES personnel, as a cohort, in each year of the study period was provided by administrators of the Army’s personnel databases. Finally, injury incidence rates previously reported<sup>2,7-9</sup> for Army populations based on other systems of data capture were compiled to provide comparison rates for reference in evaluating the performance of the WHSCAR system, with regard to incident capture rates.

## PARTICIPANTS AND ELIGIBILITY CRITERIA

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All records of WHS incidents and injuries extracted from the WHSCAR database in accordance with pre-specified criteria were checked to confirm they met the key eligibility criteria for inclusion in the study data set. Records were included in the study data set if they related to: (a) Australian Army Reserve (ARES) or Australian Regular Army (ARA) personnel; (b) an incident or injury that occurred while the person was 'on duty'; and (c) an incident or injury that occurred between 01 July 2012 and 30 June 2014, inclusive. Records were excluded if they: (a) related to personnel from Australian military services other than the Australian Army; or (b) related to personnel from a foreign defence service, on secondment.

All WHS incident and injury records were categorised by cohort, each defined by service type (ARES or ARA) of the respective participant. These ARES and ARA cohorts formed the primary basis for subsequent comparative analyses.

## OUTCOME MEASURES

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The *primary outcome measures* for the study were the incidence rates for WHS *incidents* and *injuries* that were reported as occurring in the 2-year period of interest. These incidence rates were separately calculated for each of ARES and ARA, in two forms, these being *incidents* or *injuries per 100 personnel per year* and *incidents or injuries per 100 person-years of cumulative active service*.

The *secondary outcome measures* for the study were the *injury* incidence rates that have been reported in several prior studies in Army populations.<sup>2,7-9</sup> These injury incidence rates provided a benchmark against which the relative performance of the WHSCAR system and its incident reporting approach could be assessed, with regard to capture rates of work-related injury incidents.

DATA ANALYSIS

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The WHSCAR data were provided in a raw, non-identifiable format, in a Microsoft Excel spreadsheet. Prior to analysis, the data were manually cleaned to ensure that only records consistent with the inclusion and exclusion criteria were retained. In addition, each line of data was reviewed and compared to other lines of data to ensure identification and removal of duplicate entries (ie same record entered twice).

WHS incident and injury data were subsequently entered into the Statistical Package for the Social Sciences (SPSS) Version 21.0 for statistical analysis. Descriptive analyses were first conducted to establish the numbers of WHS incidents and injuries that were reported in each of the ARES and ARA populations in each period, 1 July 2012 to 30 June 2013 and 1 July 2013 to 30 June 2014. In addition, the mean annual numbers of WHS incidents and injuries were calculated across the full 2-year period. These mean annual numbers of incidents or injuries were then divided by the mean numbers of personnel employed in the respective service type (ARES or ARA) across the 2-year study period and the resulting figure then multiplied by 100 to derive mean annual incidence rates for both WHS incidents and injuries occurring in the ARES and ARA populations, reported in terms of *incidents or injuries per 100 personnel per year*. Additionally, the total numbers of injuries and WHS incidents that were reported across the 2-year study period were each in turn divided by the total number of years of active service provided to the Army by each cohort (ARES and ARA), respectively, across the two-year study period, to derive incidence rates reported in terms of *incidents or injuries per 100 person-years of active service* (ie full-time equivalent years). When calculating total years of active service (ie total full-time equivalent years of service) for the ARES, 232 days of active service were assumed to equate to one full year of active service (or one full-time equivalent year of service) based on the following calculation:

Total days of active service typically completed in a full-time year of army service = 365d in a year – 104d weekends (or ‘in lieu’ non-service days) – 20d annual leave – 9d public holidays

Population estimates of the ARES:ARA incidence rate ratios (IRR) for both WHS incidents and injuries, indicating the ratios of incidence rates in ARES compared to ARA, were calculated using the following formula:<sup>10</sup>

$$\text{IRR} = (\text{ARES incidence rate}) / (\text{ARA incidence rate})$$

In these IRR calculations, the incidence rates used were those based on total number of full-time equivalent years of active service (rather than total number of personnel). The ninety-five percent confidence interval (95% CI) around the population estimate of each IRR was then calculated as:<sup>10</sup>

$$95\% \text{ CI} = \exp (\ln[\text{IRR}] - 1.96 \times \text{SE}(\ln[\text{IRR}])) \text{ to } \exp (\ln[\text{IRR}] + 1.96 \times \text{SE}(\ln[\text{IRR}]))$$

$$\text{where } \text{SE}(\ln[\text{IRR}]) = \sqrt{(1/[\text{incident rate}_{\text{ARES}}] + 1/[\text{incident rate}_{\text{ARA}}] - 1/n_{\text{ARES}} - 1/n_{\text{ARA}})}$$

Finally, the injury incidence rates calculated in the current study based on data from the WHSCAR database were charted against injury incidence rates reported in previous literature based on injuries reported in Army populations in other injury reporting systems. Where necessary, these previously-reported injury incidence rates were converted to provide the number of injuries per 100 person-years of active service, with reference to the respective study’s authors to clarify details if needed, to enable ready comparison to the incidence rates reported in the current study. The comparative chart was designed to provide an indication of the performance of the Australian Department of

Defence WHSCAR system relative to other injury incident reporting systems, with regard to injury incident capture rates.

## RESULTS

### ARES AND ARA POPULATIONS AND FULL-TIME EQUIVALENT YEARS OF SERVICE

The ARES and ARA populations <sup>5,6</sup> and estimated total person-years of active service (full-time equivalent years of service) during the study period 01 July 2012 to 30 June 2014 are detailed in Table 9.

TABLE 9: ARES AND ARA POPULATIONS AND ESTIMATED PERSON-YEARS\* OF ACTIVE SERVICE 2012-2014

	Population			Person-Years* of Active Service			
	ARES	ARA	Whole of Army	ARES	ARA	Whole of Army	
<b>2012 - 2013</b>	14867	28955	43822	<b>2012 - 2013</b>	2296	28955	31251
<b>2013 - 2014</b>	15200	29847	45047	<b>2013 - 2014</b>	2405	29847	32252
<b>Mean population</b>	15034	29401	44435	<b>Total person-yrs</b>	4701	58802	63503
<b>2012-14</b>				<b>2012-14</b>			

\*One person-year of active service was nominally estimated to be equivalent to 232 days of active service by deducting 104 weekend days (or 'in-lieu' non-service days), 20 days of annual leave and 9 days of public holidays from 365 total available days in a normal year

### REPORTED WORK HEALTH & SAFETY (WHS) INCIDENTS

A total of 15065 WHS incidents were reported across the two-year period of the study (2012-2013, n=7633; 2013-2014, n=7432; Table 3). Table 3 provides the incidence rates for reported WHS incidents calculated for each Service Type and for Army as a whole, based on the figures from Table 10. IRR are also provided in Table 11, indicating the ARES: ARA ratio of incidence rates for WHS incidents.

TABLE 10: FREQUENCIES OF EACH REPORTED WHS INCIDENT TYPE BY YEAR AND SERVICE TYPE

			Minor Personal Injury	Exposure	Serious Injury	Dangerous Occurrence	Near Miss	Fatality	Total
2012- 2013	ARES	Incidents	664	50	44	42	1	1	802
		% within year	83	6	6	5	0.1	0.1	100
	ARA	Incidents	4348	1774	427	273	4	5	6831
		% within year	64	26	6	4	0.1	0.1	100
2013- 2014	ARES	Incidents	704	36	22	16	10	1	789
		% within year	89	5	3	2	1	0.1	100
	ARA	Incidents	4813	1264	241	234	87	4	6643
		% within year	73	19	4	4	1	0.1	100
Total 2012- 2014	ARES	Incidents	1368	86	66	58	11	2	1591
		% within years	86	5	4	4	0.7	0.1	100
	ARA	Incidents	9161	3038	668	507	91	9	13474
		% within years	68	23	5	4	0.7	0.1	100

Note. Percentages rounded to the nearest whole percent except when <1%, rounded to the nearest 0.1%

TABLE 11: INCIDENCE RATES FOR REPORTED WHS INCIDENTS, BY SERVICE TYPE (WHS INCIDENTS PER 100 SOLDIERS PER YEAR [PER 100 PERSON-YEARS OF ACTIVE SERVICE])

WHS incident type	ARES	ARA	Whole of Army	IRR (ARES:ARA) & 95% CI
Minor personal injury	4.55 [29.10]	15.58 [15.58]	11.85 [16.58]	[1.87; 95% CI 1.78-1.96]
Serious injury	0.22 [1.40]	1.14 [1.14]	0.83 [1.16]	[1.24; 95% CI 0.96-1.59]
Exposure	0.29 [1.83]	5.17 [5.17]	3.52 [4.92]	[0.35; 95% CI 0.29-0.44]
Dangerous occurrence	0.19 [1.23]	0.86 [0.86]	0.64 [0.89]	[1.43; 95% CI 1.09-1.87]
Near miss	0.04 [0.23]	0.15 [0.15]	0.11 [0.16]	[1.51; 95% CI 0.81-2.82]
Fatality	0.01 [0.04]	0.02 [0.02]	0.01 [0.02]	[2.78; 95% CI 0.60-12.9]
Total	5.29 [33.84]	22.91 [22.91]	16.95 [23.72]	[1.48; 95% CI 1.42-1.54]

## REPORTED INJURIES

A total of 11263 injuries (comprised of minor personal injuries and serious injuries) were reported across the two-year period of the study. Table 12 details the numbers of injuries reported in ARES and ARA populations in this period. Table 13 provides the incidence rates for reported injuries calculated for each Service Type and for Army as a whole, based on the figures from Table 12. IRR are also provided in Table 13, indicating the ARES:ARA ratio of injury incidence rates. The figures presented in Table 13 indicate that the reported injury incidence rate was stable in ARES and in ARA populations, year-to-year.

TABLE 12: REPORTED INJURIES BY YEAR AND SERVICE TYPE

Years		ARES	ARA	Whole of Army
<b>2012-2013</b>	<b>Injuries</b>	708	4775	5483
	<b>% within year</b>	13	87	100
<b>2013-2014</b>	<b>Injuries</b>	726	5054	5780
	<b>% within year</b>	13	87	100
<b>Total 2012-2014</b>	<b>Injuries</b>	1434	9829	11263
	<b>% within years</b>	13	87	100

Note. Percentages rounded to the nearest whole percent

TABLE 13: . REPORTED INJURY INCIDENCE RATES, BY YEAR AND SERVICE TYPE (INJURIES PER 100 SOLDIERS PER YEAR [PER 100 PERSON-YEARS OF ACTIVE SERVICE])

Years	ARES	ARA	Whole of Army	IRR (ARES:ARA) & 95% CI
<b>2012-2013</b>	4.76 [30.84]	16.49 [16.49]	12.51 [17.55]	[1.85; 95% CI 1.72-2.00]
<b>2013-2014</b>	4.78 [30.19]	16.93 [16.93]	12.83 [17.92]	[1.80; 95% CI 1.67-1.93]
<b>Total</b>				
<b>2012-2014</b>	4.77 [30.50]	16.72 [16.72]	12.67 [17.74]	[1.82; 95% CI 1.74-1.91]



COMPARISON OF WHSCAR TO PREVIOUSLY PUBLISHED ARMY INJURY INCIDENCE RATES

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Figure 2 provides a comparison between injury incidence rates calculated for ARES and ARA populations in the current study, based on 2 years of WHS incident records contained in the WHSCAR database, and benchmark injury incidence rates derived from previously published reports of injuries in various Army contexts.<sup>2,7,8</sup>

Three<sup>7-9</sup> of the four previously published reports<sup>2,7-9</sup> indicated much higher injury incident rates for Army personnel than the rates calculated in the current study based on records from the WHSCAR system. The US Army injury incidence rate<sup>9</sup> of 160 injuries per 100 person-years of active service is indicative of a ‘whole-of Army’ injury incidence rate, and this injury incidence rate lies midway between incidence rates reported for Army recruits and for an operational brigade in the Australian Army, and thus is probably a sound estimate of overall actual injury incidence rates for Army populations, when considering injuries requiring a health care consultation. The injury incidence rates derived in this study from the WHSCAR database are similar to those derived from its predecessor DEFCARE system<sup>2</sup> and represent only 11-19% of the above estimate of the true incidence rate for injuries that are of sufficient severity to require a consultation with a healthcare provider.

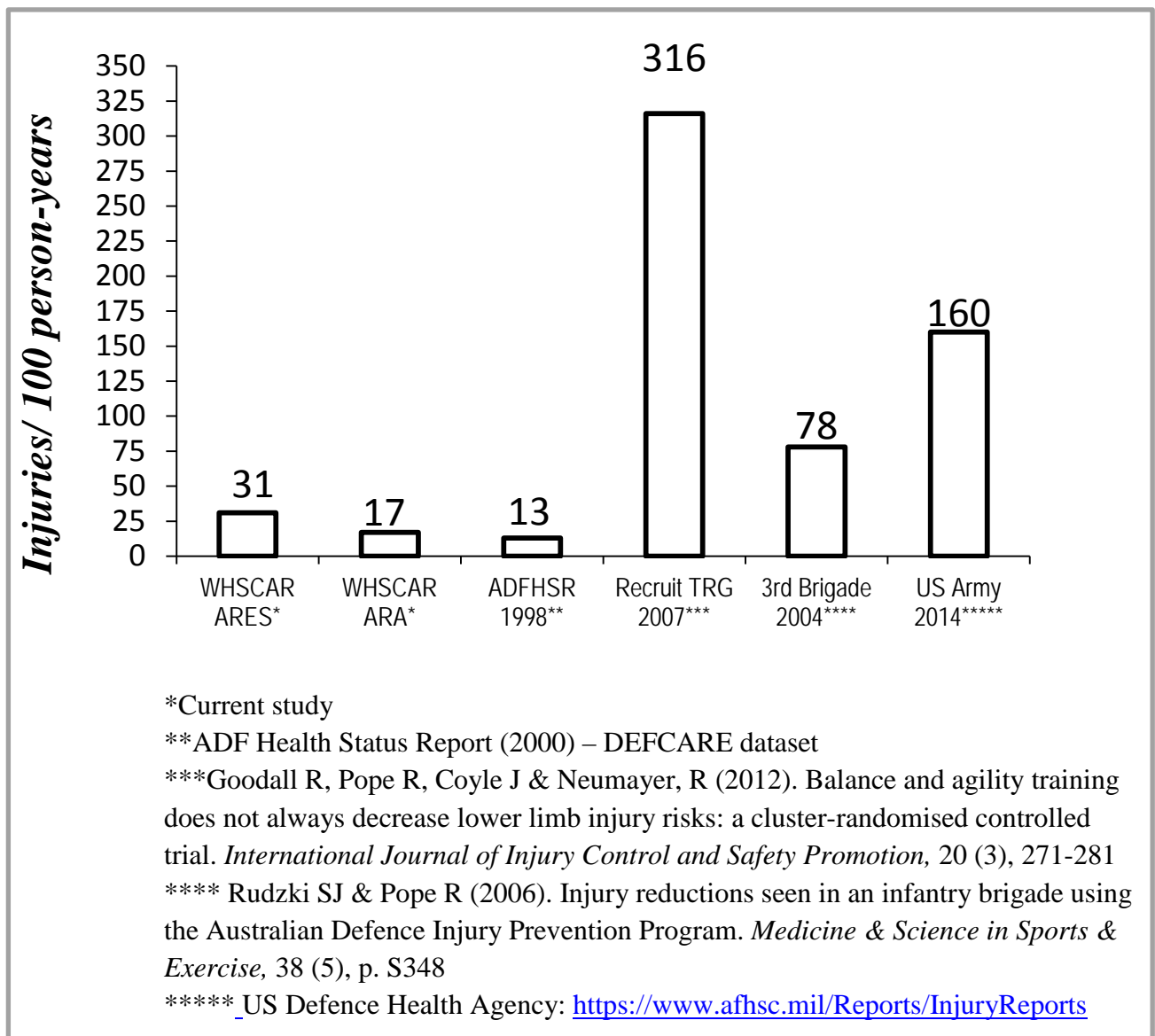


FIGURE 2: COMPARATIVE ARMY INJURY INCIDENCE RATES FROM VARIOUS STUDIES.

Information provided in these three previous reports and discussion with one of the report authors in relation to the Australian 3<sup>rd</sup> Brigade report,<sup>8</sup> indicated that the most obvious difference between the data capture approaches used in all three of these reports and the approaches used in the WHSCAR system and its predecessor DEFCARE, which gave rise to the relatively low injury incidence rates reported in the ADF Health Status report<sup>2</sup> is that all three used a ‘point-of-care’ approach to injury reporting. In this approach, injuries were recorded by healthcare personnel at the time when injured

personnel reported with their injuries to Army healthcare facilities. In contrast, the WHSCAR system and its predecessor DEFCARE system both used a system of reporting in which the injured soldier and their supervisor reported the injury incident directly to the reporting system, in accordance with Australian Department of Defence policy.<sup>4</sup> In most instances, this latter approach did not involve healthcare providers.

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## DISCUSSION

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The primary aim of our study was to establish the incidence rates for reported WHS incidents and injuries sustained by Australian Army part-time (ARES) personnel during periods of active service and compare them to those for full-time personnel. In the ARES, 34 WHS incidents were reported for every 100 person-years (ie full-time equivalent years) of active service. In the ARA, 23 WHS incidents were reported for every 100 person-years of service, suggesting that ARES soldiers experience almost 50% more WHS incidents than their full-time counterparts in the ARA, when actual days of active service are considered. The differences in injury incidence rates were even more pronounced. In the ARES, 31 injuries were reported for every 100 person-years of active service. In the ARA, 17 injuries were reported for every 100 person-years of service, suggesting that ARES soldiers experience 80% more injuries than their full-time counterparts in the ARA when days of active service are considered. However, it should be noted that we anticipated ARES soldiers may report WHS incidents and injuries at higher rates than ARA personnel, because ARES personnel need to report those incidents and injuries in order to make a worker's compensation claim to cover any medical costs they incur, whereas ARA personnel receive free medical care from the ADF. On this basis, the observed differences in incidence rates for reported WHS incidents and injuries observed in this study may not represent real differences in rates of *occurrence* of WHS incidents and injuries, but rather be an artefact of different rates of *reporting* of such incidents and injuries.

Of further interest, the observed incidence rates for both WHS incidents and injuries appear to represent just ‘the tip of the iceberg’ in both ARES and ARA populations. Comparison of the injury incidence rates alone, derived from the current study of ARES and ARA populations, to benchmark injury incidence rates from other published studies of Army populations<sup>7-9</sup> revealed that the WHSCAR database interrogated in the current study is probably only capturing reports of between 11% and 19% of all injuries actually suffered by ARES and ARA soldiers which are serious enough to warrant them seeking health care advice. This means that approximately 80-90% of all injuries suffered by ARES and ARA soldiers that are serious enough to require health care are *not* being captured on the WHSCAR system.

This latter finding has several important implications. First, these very substantial data deficits add further weight to the possibility that the observed differences in reported incidence rates for WHS incidents and injuries in the current study are *not* indicative of real, underlying differences in injury risks between the ARES and ARA and that they are instead quite possibly simply an artefact of incomplete reporting and differences between the ARES and ARA in typical reporting thresholds for such incidents and injuries. Further research with more robust data capture or sources is required to elucidate this matter. Nevertheless, it should be noted that ARES soldiers are at substantial risk of being injured and a strong focus on management of injury risks not only in the ARA but also in the ARES is warranted.

Second, noting the importance discussed in the Introduction to this paper of comprehensive data capture for adequately informing management by commanders of WHS incident and injury risks

and their flow-on effects to personnel availability and operational capability, it would seem important that the evident deficit in incident reporting and data capture is noted and addressed. A key lesson learned in the benchmarking exercise conducted as part of the current study is that those benchmark incident reporting systems which captured 5 to 10 times as many of the actually-occurring injuries in soldiers all employed a ‘point-of-care’ approach to reporting, in which health care personnel created a record of the incident or injury at the time when an injured soldier presented for healthcare. The WHSCAR system and its predecessor DEFCARE system do not employ this approach, and instead the soldier affected by the incident or injury and their supervisor are responsible to report the incident to the system (and notably not to a person).<sup>4</sup>

On this basis, it would appear prudent that developers and administrators of military WHS incident reporting systems ensure that point-of-care reporting mechanisms are incorporated in these systems to maximise data capture and so support WHS incident and injury risk management by commanders. However, it should also be noted that point-of-care reporting systems will not readily capture data on near misses, dangerous occurrences and exposures to hazards, unless they result in some sort of injury or concern requiring medical care. Thus future WHS incident reporting systems should be developed to use hybrid systems for data capture, incorporating both point-of-care and soldier/supervisor reporting approaches, with the latter approach designed to be as user-friendly as possible.

While this study has considered some aspects of WHS incident reporting systems, it should be noted that ensuring these systems can properly and comprehensively inform command risk management efforts in a timely manner depends on optimisation of many factors other than the data

capture approach employed. Additionally, data capture will also be enhanced by optimising many of these other factors, which are explicated in a previous comprehensive report by McKinnon and colleagues,<sup>3</sup> which is based on a study similarly conducted in the Australian military context. That report should also be considered by developers and administrators of WHS incident reporting systems and the military services they seek to serve.

Finally, even when WHS incident reporting systems are optimised, their proper use by commanders to inform management of risks that these systems can identify will depend heavily on the support commanders receive to identify and manage such risks. When commanders and military organisations benefit most from demonstrating low rates of WHS incidents and injuries, rather than from demonstrating sound practice in risk identification and management, little interest will be tend to be shown for enhancing the rates of identification of WHS incidents and injuries.<sup>11</sup> Lower levels of reporting and thus poorer system functioning in such contexts yield perceived benefits. Again, determinants of a sound reporting culture are well explicated in the paper by van der Schaaf and Kanse,<sup>11</sup> which constitutes further recommended reading for developers and administrators of WHS incident reporting systems and commanders.

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## CONCLUSION

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This retrospective cohort study evaluated the incidence rates of reported WHS incidents and injuries that were sustained in both ARES and ARA personnel over a recent two year period. Previously available information<sup>2</sup> of this nature is limited and aged. The results of the current study suggest that ARES personnel report 50% more WHS incidents and 80% more injuries than their ARA counterparts, when actual days of active service are considered. However, while the current study has used the best currently-available data set and certainly confirms substantial WHS incident and

injury risks in both ARES and ARA populations, which we recommend should be a focus of risk management efforts, we have also identified highly-probable, very substantial levels of under-reporting in this data set. These high levels of under-reporting, combined with the greater incentives ARES personnel may have to report their injuries, mean that we cannot be certain whether the differences in WHS incident reporting rates observed in this study represent true differences in underlying levels of risk or reflect uncertainties in the data and differences between the ARES and ARA in thresholds for reporting.

On this basis, a further important recommendation from the current study is that developers and administrators of military WHS incident reporting systems and the command elements they serve take steps to ensure the systems they use incorporate point-of-care reporting of injury incidents as well as continued reporting by affected personnel and supervisors of near misses, dangerous occurrences and exposures that do not result in significant injury. Additional advice regarding optimisation of WHS incident reporting systems and building a reporting culture has also been provided, based on recent research findings, and is worth considering.

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## **CHAPTER 4 – KNEE INJURIES IN AUSTRALIAN ARMY RESERVE SOLDIERS**

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### **PREFACE**

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Previous research has provided positive evidence for injury minimization through interventions once high risk activities and locations have been identified<sup>1-4</sup>. In order to decrease lower limb injuries amongst part-time personnel and therefore maximise Army capability, injuries sustained to the lower limbs of part-time personnel need to be analysed in greater detail. By further investigating the specific lower limb sites of injury and the nature and cause of injuries at these most commonly injured sites, interventions can be put in place to minimise both the incidence and severity of injuries suffered by the part-time population. The purpose of this chapter is to identify the most frequently injured lower limb body site in part-time personnel and to investigate the activities and mechanisms reported at the time of injury in order to inform future injury minimisation strategies to part-time personnel.

The work presented in this chapter will form the basis of the abstract submitted for the *Asics Sports Medicine Conference* in Melbourne (12-15 October 2016), and will also be developed into a full journal article for submission to the journal *BMC Musculoskeletal Disorders*.

## KNEE INJURIES IN AUSTRALIAN ARMY RESERVE SOLDIERS

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### INTRODUCTION

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An effective military force is required to be agile, capable, efficient and potent. Injury to military personnel interrupts active duty service and detracts from overall army capability<sup>5</sup>. Great emphasis is therefore placed on ensuring injury prevention strategies are put in place to minimise injuries sustained during military service<sup>1,2,4</sup>. To be effective however, these intervention strategies need to be informed by dedicated research investigating key types and sources of injury risk, so that risk mitigation strategies are directed at the most prevalent or serious types and sources of injury<sup>1,2,4</sup>.

This approach is supported by previous research which has provided positive evidence for injury rate reduction through targeted interventions, once high risk activities and locations have been identified<sup>1-4</sup>. Therefore, the aim of this study was to identify the most frequently injured lower limb body site in the population of Australian Army Reserve soldiers and to investigate the activities and mechanisms reported at the times injuries to this body site occurred, in order to inform future injury minimisation strategies.

### METHODS

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A retrospective cohort study was conducted to ascertain and compare the occupational injury profiles of part-time army personnel based on injury incident and personnel data obtained for these populations over the period 01 July 2012 to 30 June 2014, inclusive. Occupational injury data were sourced in a non-identifiable form from the Workplace Health, Safety, Compensation and Reporting (WHSCAR) database of the Australian Department of Defence, which constitutes the official record of incidents and injuries sustained by Army personnel, listed as both Minor Personal Injury (MPI) and Serious Personal Injury (SPI)<sup>6</sup>.

The primary outcome measure was the proportions of reported occupational injuries in reserve personnel which occurred at the various body locations. Secondary outcome measures comprised proportional representations at the most common body location of injury of specific: (a) natures of resulting injuries; (b) injury mechanisms; and (c) activities being performed at the times injuries occurred.

### RESULTS

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A total of 1434 injuries were reported amongst the part-time Army population within the 2-year study period. MPI accounted for 95% of these reported injuries (n=1368), with the remaining 5% (n=66) of reported injuries being classified as SPI. The knee was the most commonly reported specific body site of injury accounting for 16% (n=288) of all reported injuries. Of the total 228 reported knee injuries, 98% (n=224) were MPI and 2% (n=4) were SPI.

The most common reported nature of injury for the knee joint was *soft tissue injury due to trauma* (n=177), which accounted for 78% of all injuries to the knee. These injuries occurred most commonly in *combat training*, which accounted for 42% (n=73) of this type of injury. *Physical training* accounted for 30% (n=51) of these *soft-tissue injuries due to trauma*. *Trauma to joints and ligaments* was the second most prevalent nature of knee injury, with the most common activities being performed at the times these injuries occurred being predominantly *physical training* (n=5, 42%) and *marching* (n=3, 25%).

The most common mechanisms of injury for soft tissue injuries at the knee joint incurred during *combat training* were *falls* and *muscular stress with no object being handled* (n=27, 37% and n=21, 29% respectively). *Muscular stress with no objects being handled* was the most common mechanism of injury associated with *physical training*, accounting for 71% of the soft tissue injuries reported during that activity.

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## DISCUSSION

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This is the first known study to conduct a detailed analysis of the anatomical site of injury amongst part-time Australian Army personnel and their most common nature, location, mechanism and activity at the time of injury. The findings of this study were that the knee was the most commonly injured lower limb bodily site amongst part-time personnel.

This finding is in agreement with previous studies in military personnel with injuries at or below the knee most common<sup>1,7-9</sup>. Part-time personnel may be at more risk of injuries due to less chronic physical training than their full-time colleagues and less periodization of their training schedule due to their private employment commitments.

More dedicated combat styled training is needed for part-time personnel. Novel approaches to providing these personnel with combat styled training, eg. community-based training groups for part-time personnel may be of use. Furthermore, previous injury interventions in military training such as ankle braces for certain activities<sup>2</sup>, shock absorbing innersoles<sup>1</sup>, reducing lower limb loading by altering running surfaces<sup>3</sup> and through changing training loads<sup>4</sup> may also be of benefit.

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## CONCLUSION

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Soft tissue injuries at the knee were found to be the most common nature and site of injury amongst part-time army personnel. These injuries occurred most commonly during both combat training and physical training. This information should be used to guide injury prevention/minimisation strategies similar the successfully implemented programs documented in previous research in defence.

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## **CHAPTER 5 – A PHYSICAL TRAINING FRAMEWORK FOR RESERVE PERSONNEL: A RATIONALISATION AND RECOMMENDATIONS**

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### **PREFACE**

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Part-time Army personnel typically perform occupational and operational tasks akin to those of their active-duty counterparts but may have lower fitness due to less physical training. As such, part-time personnel may be at a greater risk of injury and have physical performance deficits. This chapter explores ideas to maximally improve fitness, performance and training guidelines for reserve soldiers. Additionally, novel ways of ensuring motivation and compliance are discussed.

The discussion paper included as part of this chapter has been submitted for publication in the *Journal of Strength and Conditioning Research*.

Orr, R., Pope, R. & Knapik, J. A Physical Training Framework for Reserve Personnel: A Rationalisation and Recommendations, *Strength and Conditioning Journal*.

## A PHYSICAL TRAINING FRAMEWORK FOR RESERVE PERSONNEL: A RATIONALISATION AND RECOMMENDATIONS

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### INTRODUCTION

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Unlike full-time regular soldiers, part-time or reserve soldiers typically have a primary employment outside of the military <sup>1,2</sup> and may be considered nomads moving between civilian and military worlds <sup>3</sup>. Often these part-time soldiers only become full-time when participating in training exercises or when called on for local or international deployment missions <sup>1</sup>. On deployments, part-time soldiers are generally expected to perform the tasks equivalent to full-time soldiers of the same rank and trade and are considered force multipliers performing an integral role in the conflict <sup>3</sup>. With operational deployments increasing in recent times <sup>3,4</sup>, part-time elements now contribute to around 10% of Australian <sup>3</sup> and United Kingdom forces <sup>2</sup>, and in the United States (US), make up about half of personnel actually engaged in current conflicts <sup>5,6</sup>. Strategically, the Australian Defence White Paper <sup>7</sup> has acknowledged the importance of integrating part-time and full-time personnel under the government approved plan, *BEERSHEBA*. As such, there is an increased requirement for part-time personnel to perform at a level commensurate with their full-time counterparts.

A vital component to military capability is physical fitness of personnel. For example, load carriage is an ongoing requirement for military personnel, during training, on field exercises and on deployments. To improve task performance while carrying load, physical conditioning and physical fitness are essential <sup>8</sup>. However, reservists may present with lower levels of some elements of physical fitness than regular soldiers <sup>1</sup>. For example, in the US, a comparison of Arizona National Guardsmen with active duty soldiers found that the guardsmen had more body fat, a lower directly measured VO<sub>2</sub>max, but higher strength than active duty soldiers <sup>9</sup>.

One contributing factor to any observed lower levels of fitness amongst part-time members may be, depending on nation, their completion of less physical training, and training in general, during their military training <sup>1</sup>. In the US, reservists and National Guardsmen train together in Initial Entry Training (IET) and in Advanced Individual Training (AIT) and thus receive the same physical

training. However, in other countries such as Australia, there are notable differences in training. As an example, in 2006 the Australian Army part-time recruit training course was only around one third the length of the full-time course <sup>10,11</sup>, at 28 days this course was two-thirds the length of the original 45 day part-time course <sup>3</sup>. Furthermore, even during full-time training, the physical training for part-time personnel may be shorter in duration, with a more focused, time critical, training program <sup>3</sup>. Long-term, chronic military physical conditioning may therefore be limited in many reserve personnel.

A second issue is the lack of training oversight once the reservists leave their initial training. Generally, reservists can train during scheduled military activities (drills, field exercises, etc) but outside of these scheduled activities, there is typically no oversight of the frequency, duration, and type of physical training performed, or even of whether it is performed.

The result of less physical training is a lower level of physical fitness among part-time reservists. These less fit soldiers are at a greater risk of injury <sup>12-14</sup> and cardiovascular concerns <sup>4</sup>. When this lower fitness level is coupled with the stress of operational duties, the risk of cardiovascular incidents may be increased, and this can significantly impact operational capability <sup>4</sup>. There is also research to suggest that physical training is essential for mental health and that perhaps the lower physical fitness and activity levels typical of part-time personnel may assist in explaining the greater risk of mental illness observed in part-time veterans <sup>2,15</sup>. It is essential that part-time soldiers are sufficiently physically fit to perform duties required of them when on occupational exercises and operations <sup>16</sup>.

The potential for injury among less fit soldiers is a major concern. The Australian Defence Health Status Report of 2000 <sup>17</sup>, found that part-time soldiers had a three times higher incidence of injuries when compared to their full-time counterparts. Recent research has suggested that this gap has narrowed, although part-time personnel were still found to report twice the incidence of injuries reported by their full-time counterparts <sup>18</sup>. Research by MacDonald et al. <sup>19</sup> found that bodily locations affected by reported incidents, while similar, did differ slightly between reservists and

full-time personnel. For example, while lower limb injuries were the leading site of injuries for both groups, they represented a slightly higher proportion of injuries in part-time personnel (part-time = 36.5%; full-time = 30.8%). Of note, the study also found that, while part-time personnel sustained a slightly lower proportion of their injuries during physical training (part-time = 20.2%; full-time = 24.6%), a much larger proportion of injuries sustained by part-time personnel arose from combat orientated training (part-time = 35.1%: full-time = 17.6%)<sup>19</sup>. Once a soldier is injured during an exercise or on operations, a time-consuming and costly (both fiscally and in terms of personnel requirements) series of requirements ensue<sup>16</sup>.

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## RECOMMENDATIONS

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### LEVEL OF FITNESS REQUIRED

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With the need to ensure part-time soldiers are physically fit, it is appropriate to measure their levels of physical fitness. Part-time soldiers are judged on the same fitness criteria as full-time soldiers but the associated fitness tests are typically designed to ensure soldier health and general fitness, rather than ensuring their occupational readiness. Furthermore, these tests employ minimum acceptable scores which are intended to represent the minimum health and fitness standard required of soldiers. The Australian Army Basic Fitness Assessment<sup>20</sup> and the U.S. Army Physical Fitness Test (APFT)<sup>21</sup>, as examples, employ fitness tests that are of a general fitness nature. These tests consist of push ups, sit ups and a run. Push ups and sit ups are measures of muscular endurance, and runs are measures of aerobic capacity<sup>21</sup>. While studies have shown low to moderate positive correlations between scores in the US APFT events and performance in occupational tasks like lifting, load carriage, casualty rescue and negotiation of obstacle courses<sup>22,23</sup>, the ability to pass these general fitness tests does not ensure part-time soldiers have the same physical capacity to perform required occupational tasks as their full-time counterparts<sup>20</sup>. The general fitness tests are, however, a good indicator of general health relative to age- and gender-based norms, and therefore remain appropriate for that purpose.

Occupationally relevant fitness assessments are, however, desirable and should form the precursor to any ongoing integration of part-time with full-time personnel. Standards like the Australian Army Physical Employment Standards - Army (PESA) present as a viable measure and option. The PESA standards are based on occupational requirements regardless of gender and age<sup>24</sup>. On this basis,



these requirements can also be considered to be independent of service type - part-time or full-time. After all, the physical demands of participating in a given operational patrol will be the same for all personnel. For example, the weight of a box or other load that has to be moved will not vary with service type, age or gender. This is an important consideration, as there may be a temptation to reduce testing standards or modify assessments to accommodate the lower fitness levels of part-time personnel and limit potential injury from overtraining. If the nature of the task will not change due to part-time status, then the nature of the occupational assessment should likewise not change. Furthermore, as lower levels of fitness are associated with an increased risk of injury during tasks with fixed workloads<sup>13,14</sup>, lowering fitness standards for part-time soldiers is likely to heighten their potential for injury when performing these given military tasks. On this basis, if lower fitness and potential for injury are concerns, then the training and preparation must adapt to meet the occupational need rather than changes being made to the assessment standard.

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### CONDITIONING

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Providing conditioning programs to part-time personnel presents a challenge<sup>25</sup>, yet the importance of optimal physical conditioning for part-time personnel cannot be understated, especially if they are being conditioned for deployment. Research suggests that on combat operations, non-combat activities often account for more injuries than actual combat<sup>26,27</sup>, with the lower back typically presenting as the leading site of such injury<sup>26-29</sup>. Potential reasons for these injuries include the wearing of body armour and load carriage. Wearing body armour has been found to increase the physical demands of performing a given task<sup>30</sup> and as such it is not unexpected that it is associated with lower back injuries<sup>31</sup>. One study by Roy et al.<sup>28</sup> identified lifting and carrying, dismounted patrolling and physical training as the activities associated with injuries among soldiers on an operational deployment in Afghanistan. Considering this, it is reasonable to expect that physical conditioning would be of benefit to improve load carriage, lifting and carrying resilience, fatigue resistance in dismounted patrolling and physical training capability<sup>32-35</sup>.

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### NATURE OF CONDITIONING

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The nature of the physical conditioning undertaken to improve various components of physical fitness<sup>36</sup> can be designed to facilitate two key outcomes, these being (i) general health, fitness and well-being, and (ii) occupational capability. General health, fitness and well-being are of particular importance to military forces, as poor general health and fitness have been associated with an increased risk of cardiovascular and metabolic disease and illness<sup>37</sup> and an increased risk of

sustaining an injury during military training<sup>38,39</sup>, both of which would impact on Service Member availability. Research in tactical populations (including law enforcement and military) has noted that part-time personnel may have a higher fat mass than full-time personnel<sup>9,40</sup>, may be slightly overweight (based on BMI)<sup>41</sup> and may have lower levels of some aspects of fitness<sup>9,40,42</sup> – all factors associated with an increased risk of cardiovascular and metabolic syndromes<sup>43</sup>. Furthermore, low levels of aerobic fitness have been found to be a leading factor associated with injury in tactical populations during training<sup>13,38,39,44</sup>. A higher level of general health and fitness may aid in reducing the risk, and impact, of mental illness, which is greater in part-time veterans<sup>2,15,45</sup>. On this basis, general conditioning to increase overall health and fitness would be of benefit to the part-time soldier and the organisation as a whole. Some organisations perform fitness testing and these assessments can be used as a surrogate to evaluate health and fitness and monitor the effectiveness of training programs to improve or maintain fitness.

The recommended requirements to maintain health and fitness in the general population are between three days (vigorous exercise intensity) and five days (moderate exercise intensity) of physical activity per week, with sessions totalling 75 to 150 minutes per week depending on intensity<sup>43</sup>. In addition, for neuromuscular conditioning, each major muscle group should be trained two to three days per week<sup>43</sup>. Given these guidelines, as a general estimate, part-time members would ideally need to exercise at least three times per week for 50-60 minutes including both anaerobic/aerobic exercise and muscle power/ strength/endurance conditioning. These sessions could, for example, be comprised of an eight to 10 minute warm up, 15 to 20 minutes of neuromuscular conditioning, 25 to 30 minutes of moderate to vigorous aerobic activity and a five minute cool down with the order dependent of conditioning dependent on which component of fitness was to have the higher intensity.

Besides meeting general health and fitness training requirements, the additional need for task specific conditioning to be conducted must also be considered. Given the specific nature of military occupations, task specific conditioning is a priority if part-time members are to be effectively integrated with full-time members. Load carriage presents as a prime example of a task specific requirement of the military and as such, one required of part-time personnel; a consideration noted

by Lindberg et al.<sup>46</sup> as a requirement for part-time firefighter integration. During field exercises, soldiers can carry loads of 47 kg, with these loads increasing to over 60 kg on combat operations<sup>47,48</sup>. Conditioning for load carriage must, at a minimum, incorporate both aerobic training, muscle strength training, and load carriage specific conditioning<sup>8,49</sup>.

Task-orientated conditioning is not new and has been found to have a positive impact on task performance and fitness in general<sup>50</sup>. Four studies in the United States that replaced many traditional military training activities with task-orientated training, including movement drills and interval training, demonstrated that the application of task-orientated training had no negative effect on general fitness development when compared to the traditional programs<sup>51-54</sup>. On this basis, replacing some general health and fitness conditioning sessions with task-orientated conditioning can provide a measure of occupation-specific conditioning without detriment to the general health and fitness conditioning requirements of soldiers.

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#### MOTIVATING AND MONITORING TRAINING IN PART-TIME SOLDIERS

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With part-time members typically only attending military training nights once per week or on occasional weekends per month, meeting recommended requirements of at least three physical training sessions per week is not achievable during military training time. As such, providing part-time forces with the same conditioning stimulus as full-time forces and making such programs available to part-time personnel is a notable challenge<sup>25</sup>. In the first instance, it is recognised that reserve personnel need to be exposed to the same optimal conditioning practices as full-time personnel. For example, specific load carriage physical training sessions are recommended to be conducted, at a minimum, every seven to 14 days<sup>8,49</sup>. Anaerobic / aerobic and muscular conditioning should be conducted 3 and 2 times per week, respectively, and are not only associated with lower injury risk but can also improve occupational task performance<sup>36,55</sup>.

Considering these recommendations, there are several practical elements that must be considered when attempting to ensure that reserve personnel receive an adequate training stimulus. Load carriage presents as a prime example. While wearing combat equipment (including body armour as required) and carrying a weapon form part of the specificity of training for load carriage conditioning, this option will be restricted for reserve personnel when they are not training at Army

training grounds. This is not only because of a lack of access to the specific equipment, but also because of the fear and security concerns that a camouflaged figure carrying a military pack and weapon (or mock weapon) and moving through a civilian area are likely to cause. A compromise may be cargo style civilian clothing, boots, coloured backpack with load and a clearly discernible commercial product to simulate carrying a loaded resistance in the hands (e.g. kettlebell, modified Olympic bar etc.). Even if a specific load carriage exercise cannot be accomplished for some reason, specific aerobic and muscle strength training can still result in some improvement to load carriage performance, although optimal training would include a load carriage task (24).

Given the constraints on physically training reserve personnel, a program to monitor and motivate regular, systematic training of these Soldiers should be considered. Monitoring is important – especially if remunerating the members or participation forms part of administration (e.g. promotion) requirements. However, without formal attendance at a physical location, the ability to monitor compliance to physical training requirements may also be more difficult. As such, there may be a need for the member to maintain a training logbook. These logs could, however, be misused. If a training application on a mobile communication device could be devised, unit members could report the details of the training session immediately on conclusion. The application could have a form akin to those of traditional physical training logs and be linked to the member's unit training officer, who would manage compliance. If optimally designed, the application could feed into a master program which would display all personnel under the charge of the unit training officer and could provide outputs of compliance reports as needed (e.g. weekly, fortnightly, monthly, etc.).

Performance monitoring devices, which are becoming increasingly available and popular, may also be of benefit. Heart rate monitors, Global Positioning Systems (GPS) and similar smart technologies can be used to measure and record physical activity effort, distances covered, and other aspects of training sessions (e.g. speed). These devices can add an additional level of accuracy in reporting given that they would be more difficult to falsify.

To assist in maintaining motivation and a fitness mindset, community-training groups could be established whereby groups of reserve members all attend a local training facility or area together to train. Not only may this enhance motivation but it likewise has the potential to increase teamwork

and cohesion. Through training in groups, unit reporting of physical training may also be improved, especially if a senior member is authorised to record, and report, attendance. To foster will-to-win, virtual competitions between community groups could be developed and encouraged.

An alternative or supplement to this approach, particularly when reserve personnel are geographically dispersed or have difficulty arranging frequent group training sessions due to other commitments, may be to use social media or other online or mobile software tools to record and track individual training and achievements and compare these to virtual group averages or even to other individuals within the virtual group. Individual progress could then be routinely verified by objective testing at training days, when personnel attend sessions with their unit. Such an approach may provide a healthy level of individual competition and motivation by group belonging and comparison, to inspire fitness training and achievements by individual personnel. Additionally, these types of approaches could also be used to share training ideas and information, much like full-time personnel discuss their training regimes with their peers and instructors when at work.

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## CONCLUSION

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Part-time and full-time personnel are typically required to perform tasks at a commensurate level. However, part-time personnel may not have the same level of chronic conditioning when compared to full-time personnel. As such, part-time personnel have been observed to present with lower levels of fitness and a higher BMI and levels of body fat when compared to full-time personnel, the downstream effects of which may predispose them to a greater risk of injury during military training and operations. Opportunities to mitigate this risk and increase the physical conditioning are hampered by many factors, including the competing commitments of part-time personnel and limitations in performing some forms of physical conditioning (like load carriage). However, approaches like maintaining a log book on a digital application, the use of performance monitoring devices (e.g., heart rate and GPS) and community-based training groups (physical or virtual) may provide a means of monitoring the physical training of part-time personnel and provide a source of motivation through which to optimise their physical fitness.

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## CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

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In conclusion, the findings of this program of research suggest that part-time personnel employed in tactical populations may typically exhibit higher levels of body fat and a higher BMI than full-time personnel. In addition, these personnel may have lower levels of aerobic fitness and strength—although this finding is not always consistent. With lower levels of chronic tactical conditioning, due partly to reduced access to ‘on-duty’ tactical training, part-time personnel may be at a greater risk of injury when compared to full-time personnel.

Although the current program of research did not specifically assess the relationship between fitness levels and injury risk in the Army Reserve (ARES) population, the assumption that ARES would probably exhibit an increased risk of injury was found to be accurate when comparing reported incidence and injury data for part-time Army Reserve (ARES) personnel to that for full-time Australian Regular Army (ARA) personnel. In general, ARES personnel reported 50% more workplace health and safety (WHS) incidents and 80% more injuries than their ARA counterparts when actual days of active service were considered. However, for both populations, research suggests that, due to limitations within the current reporting system, these figures may be an underrepresentation of the actual injuries suffered.

The leading site of injury for ARES personnel was the lower limbs, with a proportional representation slightly higher than observed in the ARA population. The leading body structures injured were soft tissues, with muscular stress while lifting, carrying and donning equipment a leading mechanism, closely followed by falling. Unlike the ARA, the leading activities at the time of injury in the ARES were combat tasks (including patrolling), with combat tasks representing double the rates at which they were reported as the leading activity in the ARA population.

With the proportional representation of physical training injuries being similar, albeit slightly lower, in the ARES population when compared to the ARA population, lower levels of Army-organised, combat orientated activity participation for ARES soldiers may be one reason for the observed differences in reported incidence rates of WHS incidents and injuries. Based on the literature on

tactical populations, other reasons may include (but are not limited to) possible differences between ARES and ARA in reporting thresholds; the aforementioned lower levels of chronic conditioning in part-time personnel; the typically lower levels of general physical fitness observed in part-time tactical personnel; and reduced opportunities for optimal training in ARES personnel, in part due to their competing civilian work obligations.

Proposed recommendations regarding training optimisation for ARES personnel include the use of technology to enhance group training and individual and group benchmarking opportunities; the use of alternative training equipment better suited to a civilian context; increased accountability of ARES personnel for their training engagement; and specific guidelines regarding optimal frequency and intensity of training.

In summation, this program of research has highlighted several notable research and practice gaps, which warrant further research and practice development. First, developers and administrators should consider incorporating ‘point-of-care’ incident/injury reporting within WHS incident reporting systems to enhance data capture (and thus statistical power) to detect existing and emerging WHS and injury risks, and to more reliably inform future studies. Second, key sources and patterns of injuries in ARES personnel warrant dedicated research and practice improvement efforts to investigate and remediate the causes of injuries. Third, rigorous intervention studies and an evaluation of practice changes are needed to confirm the effectiveness of practice approaches recommended in the current report. Finally, well-designed, pragmatic qualitative research would also be beneficial to explore in depth the experiences of ARES personnel in relation to:

- maintaining physical conditioning;
- reducing risks of WHS incidents and injuries;
- balancing civilian and military occupational commitments; and
- barriers to and facilitators for optimal engagement in training for military physical conditioning and military skill development.

## RECOMMENDATIONS

Given the identified research and practice gaps discussed above, four key recommendations are proposed: 1) to improve the quality of incidence surveillance data collection; 2) to further identify the key sources and patterns of injuries in ARES personnel; 3) to establish a detailed ARES fitness profile (for comparison to that of ARA personnel) and to identify ARES-specific barriers to physical training; and 4) to implement strategies to increase physical training and improve fitness in order to specifically reduce the identified types of injuries suffered by ARES personnel. Each of these recommendations is discussed in further detail below.

### RECOMMENDATION 1: IMPROVE THE QUALITY OF INCIDENT SURVEILLANCE DATA COLLECTION

The Tactical Research Unit (TRU) team has extensive experience in developing and implementing effective ‘point-of-care’ data capture systems for injury surveillance, thereby enhancing data capture (and thus statistical power); detecting existing and emerging WHS and injury risks; and more reliably informing research. The team has previously provided extensive documented and specific advice to the Australian Army and Department of Defence on this matter, and has also developed and evaluated an initial ‘proof of concept’, clearly demonstrating its utility.

The next step will be to upscale and further modernise this system to exploit currently-available technology for data capture, and to extend the real-time data analysis, information dissemination and commander alert capabilities of the system. A small-scale pilot trial and evaluation will then be in order, prior to further system refinement and broader roll-out. As the Australian Department of Defence has not indicated a capacity to support this future work, we are currently examining alternative options to complete a proof of concept with another large tactical or industrial organisation in Australia or overseas, with potential joint commercialisation prospects in the longer term.

Priority	Timeframe to achieve	Anticipated costs (to pilot)
Moderate	3–5 years	\$500,000

RECOMMENDATION 2: FURTHER IDENTIFICATION OF KEY SOURCES AND PATTERNS OF INJURIES IN ARES PERSONNEL

Through further detailed and thorough investigation of injuries sustained by ARES personnel and their key sources, a better understanding of injury patterns can be established. This will in turn inform intervention strategies, and ultimately provide a benchmark against which to assess the effectiveness of these interventions.

To achieve this recommendation, current incidence and injury data need to be further analysed in detail. Notable injury body sites, mechanisms and activities need to be examined in context, with dedicated sub-analyses performed to develop further understanding of how and why these injuries occur.

Priority	Timeframe to achieve	Anticipated costs
Moderate	1 year	Nil*

\* See paragraph discussion below

The Tactical Research Unit (TRU) at Bond University has already begun further investigating this data. As an in-kind contribution to the Australian Defence Force and to further leverage the research funded by the Defence Health Foundation, the TRU will continue to analyse the data obtained for the current program of research to determine specific leading body sites of injury in the ARES, and it will continue to investigate the types of structures injured, the causes, and the activities being performed at the time of injury. In addition, a detailed analysis of the leading causes of injuries suffered by ARES personnel, the body sites injured by these causes, and the activities being performed at the time of injury will be conducted. A similar approach will be taken to investigate the *nature* of injuries suffered by ARES personnel. Finally, a detailed analysis of ‘near misses’, ‘dangerous occurrences’ and ‘hazardous exposures’ experienced and reported by ARES soldiers will be undertaken.

RECOMMENDATION 3: ESTABLISH A FITNESS PROFILE OF ARES PERSONNEL IN COMPARISON TO ARA PERSONNEL AND IDENTIFY ARES SPECIFIC BARRIERS TO PHYSICAL TRAINING

Previous research suggests that part-time personnel are less fit than full-time personnel, a supposition supported by higher rates of injuries observed to have been reported by ARES soldiers in this program of research. By identifying differences in fitness levels between populations, and further investigating the relationships of these differences to the injuries suffered by ARES personnel, targeted intervention strategies can be developed. However, these implementation strategies will need to take into account potential barriers that will exist in the ARES population.

Army Basic Fitness Assessment, Army Physical Employment Standards and unit-specific fitness assessment results could be collected to profile the fitness of ARES personnel. This data could then be compared to equivalent data from a well matched cohort of ARA personnel via purposive sampling. To identify barriers that may be faced by ARES personnel to their participation in physical training, either a qualitative study involving interviews or focus groups or a survey sent to ARES personnel could be used to establish barriers, and then to gauge the potential for recommended solutions that will be effective in the ARES population.

Priority	Timeframe to achieve	Anticipated costs
High	Up to 1 year	\$50,000–\$100,000

RECOMMENDATION 4: IMPLEMENT STRATEGIES TO INCREASE PHYSICAL TRAINING AND IMPROVE FITNESS TO SPECIFICALLY REDUCE IDENTIFIED ARES INJURIES

Acting on the findings from this program of research and those of Recommendations 2 and 3, rigorous intervention studies and an evaluation of practice changes would be needed to confirm the effectiveness of practice approaches. These interventions could be trialled at both training institutions responsible for the training of new ARES personnel as well as within established ARES units. Outcome measures could include a review of subsequent unit fitness assessments results as well as targeted comparisons of injury surveillance data against comparative retrospective data.

Priority	Timeframe to achieve	Anticipated costs
High	1–3 years	\$100,000–\$150,000

#### FINAL COMMENTS

For these recommendations to be actioned and sustained, it will be important that Army policy and governance explicitly support and encourage the implementation of such strategies. In addition, processes, appropriate directives and supporting documentation would need to be put in place to ensure that, while the recommendations could be enhanced and reaffirmed, they would maintain longevity by not dissipating following a posting cycle or through personality influence.

## CHAPTER 7 – FUTURE RESEARCH AND DIRECTIONS

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Following the formal completion of the current program of research funded by an *Establishment Grant* from the Defence Health Foundation, the future research and directions to be undertaken by the Tactical Research Unit (TRU) from Bond University will seek to further advance the program's findings. This continuing commitment will be achieved through three lines of development: 1) continued investigation of current data; 2) submission and presentation of research findings; and 3) the seeking of additional funding and grants to support the recommendations.

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### CURRENT PROJECTS AND FORWARDING FUTURE PAPERS

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As noted in Chapter 6, the TRU has several additional research projects underway to support Recommendation 2. These projects include a detailed investigation of 1) the leading body site of injury in the ARES; 2) the leading causes of injuries suffered by ARES personnel; 3) the nature of injuries suffered by ARES personnel; and 4) 'near misses', 'dangerous occurrences' and 'hazardous exposures' experienced and reported by ARES soldiers.

The results of these research projects will be disseminated (once cleared through Joint Health Command) through peer-reviewed publications (i.e. *BMC Musculoskeletal Disorders* and the *Journal of Military and Veterans' Health*), as well as national/international conferences in 2016 and potentially 2017 (i.e. Australasian Military Medicine Conference, Sports Medicine Australia Conference and the 4<sup>th</sup> International Congress on Soldiers' Physical Performance).

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### FUNDING

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To support the implementation of Recommendation 3, the TRU has submitted an Expression of Interest (EOI) for grant funding under the Army Research Scheme. This EOI is shown in Appendix 4, with the 'Summary of Research and Methodology' described below.

Building on the Australian Army Reserve injury profile developed through a Defence Health Foundation grant in 2015, two phases of research will commence.

*Phase 1:* To establish current ARES fitness levels, ARES fitness assessment data (Army Basic Fitness Assessment data and Army Physical Employment Standards) will be sourced through 2nd Division units. In addition, data will be sourced from the Royal Military College – Australia to examine ARES officer cadet entry standards. Comparative ARA data will be captured via purposive sampling. Data will be analysed descriptively and inferentially (independent sample t-tests and Analysis of Variance).

*Phase 2:* Focus groups will be conducted with, and surveys distributed to, ARES Staff (2nd Division) to capture user-level feedback on the challenges to developing and maintaining fitness as an ARES member. Data will be analysed thematically using content analysis. Following data analysis, recommendations will be generated to facilitate improved health, fitness and physical performance among ARES personnel. The conclusion of this project will be marked by the generation of a report to Army and two research journal articles for publication.

In addition to this grant application, other sources of funding to support the provided recommendations are currently being sought.



## APPENDICES

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Appendix 1: Critical review – AMMA conference presentation



Appendix 2: Profiling ARES WHS Incidents and injuries paper, presented at AMMA conference ARES

Appendix 3: Incidence rates paper, presented at AMMA conference

Appendix 4: Army Research Scheme Expression of Interest

## APPENDIX 1: CRITICAL REVIEW – AMMA CONFERENCE PRESENTATION

Differences in physical characteristics and performance measures of PT and FT tactical personnel: A critical narrative review

Dylan MacDonald<sup>2</sup>, Rob Orr<sup>1</sup> & Rod Pope<sup>1</sup>  
<sup>1</sup>Tactical Research Unit, Bond University <sup>2</sup>Bond University

Background

- Tactical personnel (i.e. military, law enforcement and fire and rescue personnel) routinely perform physically strenuous occupational tasks, requiring muscular strength, endurance and cardiovascular fitness





















<http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7610.2014.01601.x>  
 1 Dec 2014  
<http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7610.2014.01601.x>  
<http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7610.2014.01601.x>  
 1 Dec 2014

Defence Health Foundation




Background


- These services are comprised of both PT and FT personnel, with both groups expected to perform similar occupational tasks, at equivalent levels

(Lindberg, 2014; Williams, 2005)








Defence Health Foundation




Background

- PT personnel on-the-job physical training typically continues to be at a lower frequency than that of FT personnel  
 (Pickup, 2009; Williams & Evans, 2007; Williams; 2005)
- PT personnel often have to balance other occupations and work demands with their tactical role, and so frequently have to be responsible for their own physical training sessions  
 (Pickup, 2009; Williams & Evans, 2007)

Defence Health Foundation





## Aim of the Review

- ...to critically appraise and discuss the findings of existing research that has compared the physical characteristics and physical performance capacities of PT and FT tactical personnel

*This research was supported by a grant from the Defence Health Foundation*



## Methods

1. Literature databases searched : PubMed, CINAHL, EBSCO, and Web of Science were searched using key search terms.

PubMed	("full-time" OR "part-time" OR "reserve") AND ("home guard" OR "army" OR "defence" OR "defense" OR "police" OR "military" OR "soldiers" OR "firefighters" OR "first responder")
CINAHL	("full-time" OR "part-time" OR "reserve") AND ("home guard" OR "army" OR "defence" OR "defense" OR "police" OR "military" OR "soldiers" OR "firefighters" OR "first responder")



## Methods

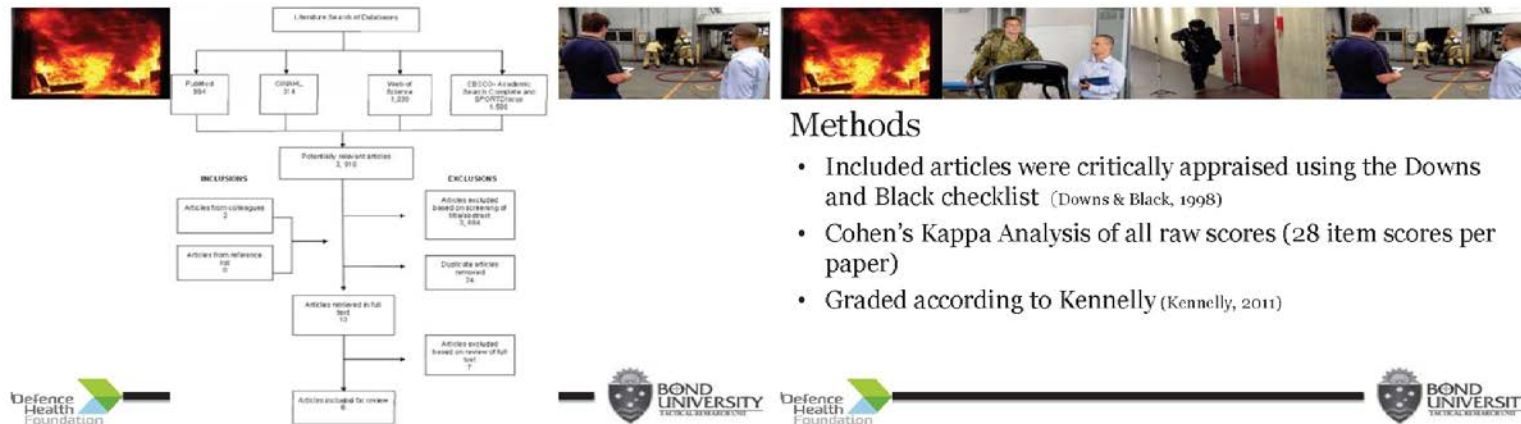
2. Reference lists of included articles were manually searched, and
3. Colleagues with expertise in the topic area were asked to identify any additional articles of relevance.



## Methods

- The inclusion criteria were:
  - (a) the study was published in the English language;
  - (b) the study involved human participants;
  - (c) the study was published in 1994 or later;
  - (d) the study involved participants from tactical populations
  - (e) the study included both part-time and full-time participants
- The exclusion criterion was any study that did not examine anthropometric or physical performance measure(s)









## Results

- Physical characteristics were measured using:
  - Anthropometry or body composition (Dawes et al., 2013; Williams & Evans, 2007, Williams, 2005)



## Results – Body Composition

- PT
    - mean BMI ranged from  $23.5 \pm 4.4$  to  $30.1 \pm 3.2$  kg/m<sup>2</sup>
    - mean BF% ranged from  $14.0 \pm 4.4$  to  $20.4 \pm 3.5\%$
  - FT
    - mean BMI ranged from  $22.0 \pm 2.1$  to  $26.3 \pm 2.3$  kg/m<sup>2</sup>
    - mean BF% ranged from  $10.7 \pm 2.6$  to  $18.9 \pm 4.0\%$
- (Dawes et al., 2013; Williams & Evans, 2007; Williams, 2005)





## Results – Cardiovascular Fitness

- PT
  - mean  $VO_{2max}$  ranged from  $40.9 \pm 6.1$  to  $47.69 \pm 7.64$  mL/kg/min
- FT
  - mean  $VO_{2max}$  ranged from  $44.8 \pm 4.9$  to  $50.10 \pm 7.05$  mL/kg/min

(Lindberg, Malm et al., 2014; Wynn & Hawdon, 2012; Williams & Evans, 2007; Williams, 2005)



## Results – Cardiovascular Fitness

- *Of note:*
  - *part-time firefighters and home guard personnel found to have an estimated  $VO_{2max}$  of 50.1 and 53.0 mL/kg/min (Aandstad et al., 2014; von Heimburg et al., 2006)*



## Results – Musculoskeletal Fitness

- PT SWAT:
  - VJ  $55.40 \pm 6.65$  cm, Sit Ups  $56.52 \pm 12.89$ , Push Ups  $64.52 \pm 14.05$
- FT SWAT:
  - VJ  $68.94 \pm 9.55$  cm, Sit Ups  $82.70 \pm 8.52$ , Push Ups  $89.46 \pm 12.95$

(Dawes et al., 2013)



## Results – Task Performance

- Williams & Evans, 2007: No statistically significant differences between PT & FT soldiers for any variables assessed inc: Lift and Carry tasks.
- Lindberg, Oska et al., 2014: No overall statistically significant differences observed between PT & FT firefighters
  - Seven simulated firefighting work tasks
  - However found sig differences in task effort ratings (Lindberg, Malm et al., 2014)





## Conclusions

- The available evidence re: PT & FT is of moderate methodological quality



Defence Health Foundation

[http://www.bonduniversity.edu.au/defence\\_health\\_foundation](http://www.bonduniversity.edu.au/defence_health_foundation)

[http://www.bonduniversity.edu.au/defence\\_health\\_foundation](http://www.bonduniversity.edu.au/defence_health_foundation)



## Conclusions

- Generally, the research indicates that PT personnel exhibit higher BMI and BF% and lower levels of aerobic capacity and strength than FT personnel
- However, findings were variable and may reflect variation across populations in different PT & FT personnel - regular work frequencies and intensities, and individually and institutionally-arranged physical training regimes

Defence Health Foundation



## Acknowledgement

- The Defence Health Foundation



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Defence Health Foundation







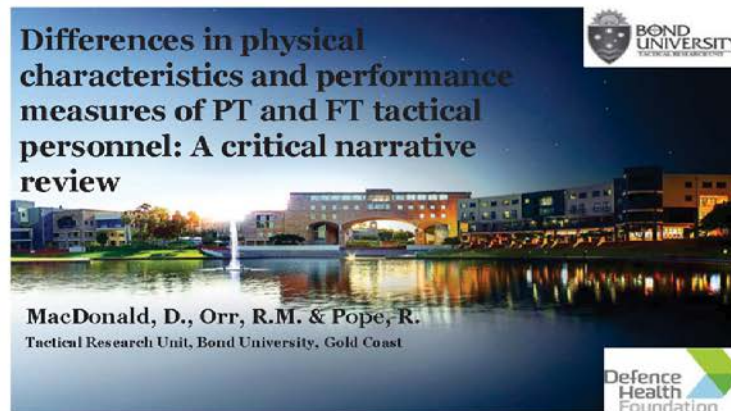
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## APPENDIX 2: PROFILING INCIDENTS AND INJURIES PRESENTED AT AMMA CONFERENCE



### Background

- The Australian Army is comprised of both part-time and full-time personnel  
(ADF Health Status Report, 2000; Defence White Paper 2013)
- However, unlike full-time regular soldiers, part-time soldiers (or 'reservists') typically have primary employment outside the military and only become full-time soldiers when called upon to participate in training exercises and local or international military operations  
(Williams, 2005)



### Background

- With active service of this nature becoming increasingly more frequent in recent years, these part-time personnel are no longer considered to be 'back up' personnel, but rather to be integral to the successful functioning of the full-time forces  
(Smith & Jans, 2011)

(Smith & Jans, 2011)



### Background

- With operational deployments increasing, part-time soldiers now contribute to around 10% of Australian and UK forces  
(Smith & Jans, 2011; Dandeker et al., 2011)
- In the US, reservists make up approximately half of personnel actually fighting in current conflicts  
(Moore & Barnett, 2013)

(Moore & Barnett, 2013)





### Background

- Strategically, the ADF Defence White Paper has acknowledged the importance of integrating ARES and ARA personnel under the government approved plan, BEERSHEBA  
(Defence White Paper 2013)
- For this reason, the ability of ARES personnel to effectively work and keep pace with their ARA peers, without experiencing excessive numbers of work health and safety incidents or injuries, is vital  
(Moore & Barnett, 2013)



### Background

- Ultimately, work health and safety incidents and resulting injuries affect both populations  
(ADF Health Status Report, 2000; Defence White Paper 2013)
- Despite the importance of this Reserve capability, preliminary research conducted by the ADF in 2000, based on limited data, suggested that part-time ADF personnel were three times more likely to report injuries that had occurred during physical and military training than full-time personnel



### Aim

- To profile the incidents & injuries reported in Part-time compared to Full-time soldiers serving in the Australian Army

*This research was supported by a grant from the Defence Health Foundation*



### Methods

- Retrospective cohort study, covering 01 Jul 2012 – 30 Jun 2014
- Incident data for ARES & ARA extracted from WHSCAR database by system administrators & made non-identifiable
- Inclusion Criteria:
  - Incident or injury sustained by Part-time or Full-time personnel
  - Incident or injury occurred during 01 July 2012- 30 June 2014
- Exclusion Criteria:
  - Foreign defence service on secondment
  - Missing data





## Methods

- Population sizes ascertained from annual Defence Agency Resources & Planned Performance reports
- Total annual numbers of ARES days served provided by AHQ



## Methods

- Data analysis:
  - Comparison of the types, source & mechanisms of these incidents
  - Frequency distributions of key incidents
  - Compare Part-time vs. Full-time incidents & injuries
  - Incidence & injury rates Year One vs. Year Two



## Methods

- Ethics approval from ADHREC (LERP14-024) & BUHREC (RO1907)
- Abstract approved for presentation by JHC (150707)



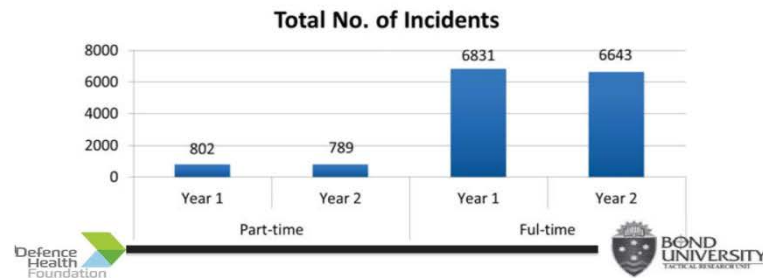
## Results

ARES and ARA Population Sizes 2012-2014

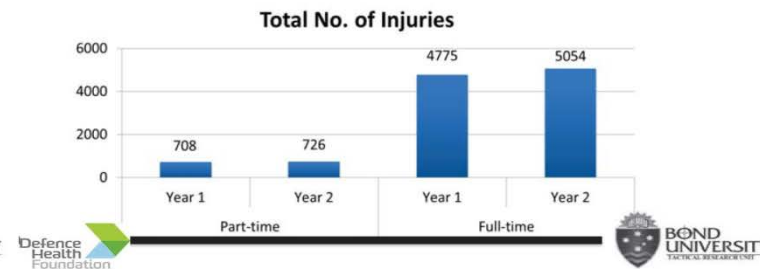
	ARES	ARA	Whole of Army
2012 - 2013	14867	28955	43822
2013 - 2014	15200	29847	45047
Mean pop. 2012-14	15034	29401	44435



## Results



## Results



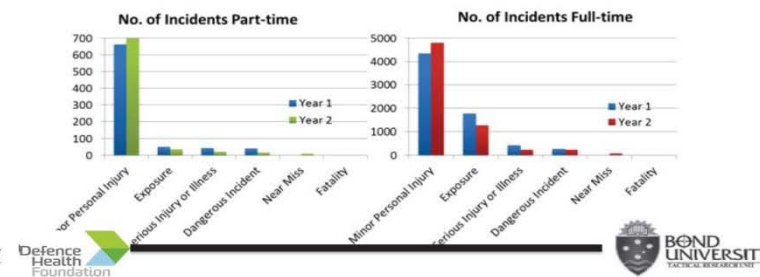
## Results - Incidence rates, by year and Service type

Years	ARES	ARA
2012-2013 (1 year)	30.84	16.49
2013-2014 (1 year)	30.19	16.93
2012-2014 (2 years)	30.50	16.72

Injuries per 100 person-years of active service



## Results







Results - Body locations affected by reported WHS incidents, by Service type

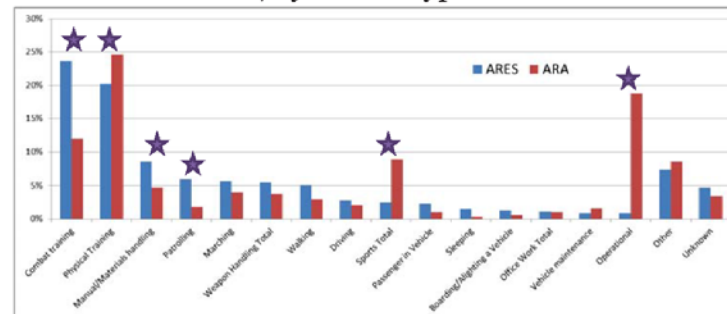
Body location	ARES	ARA	Whole of Army
Lower limb	36.5%	30.8%	31.4%
Trunk and Pelvis	23.4%	21.2%	21.4%
Upper limb	14.6%	9.5%	10.0%
Systemic	10.6%	22.8%	21.5%
Head	8.3%	7.8%	7.9%
Other	6.6%	7.9%	7.8%
Total	100.00%	100.00%	100.00%



Results - Mechanisms of injuries resulting from reported WHS incidents, by Service type

Mechanism of injury	ARES	ARA	Whole of Army
Muscular stress while lifting, carrying or donning equipment	34.8%	31.6%	31.9%
Fall	20.2%	14.9%	15.5%
Contact with moving or stationary object	12.1%	10.3%	10.4%
Chemical substance	5.5%	18.1%	16.8%
Vehicle accident	3.0%	3.3%	3.3%
Insect and spider bites and stings	2.3%	0.5%	0.6%
Contact with, or exposure to, biological factors of unknown origin	2.1%	2.3%	2.3%
Contact with hot objects	1.9%	0.4%	0.5%
Exposure to environmental heat	1.9%	1.6%	1.7%
Rubbing and chafing	1.1%	0.5%	0.6%
Long term exposure to sounds	0.2%	1.6%	1.4%
Other and multiple mechanisms of injury	13.8%	13.8%	13.8%
Unspecified mechanisms of injury	1.1%	1.1%	1.2%
Total	100.0%	100.0%	100.0%

Results - Activities during which reported WHS incidents occurred, by Service type



## Discussion

- The lower limbs were the leading body location affected
  - ARES slightly higher than ARA when compared to the regular army population.
  - Lower limbs in particular have been previously found to be the leading body location of injury in military personnel (Knapik et al., 2001; Kaufman et al., 2000)
- Lower limb injuries across Army in this study = 31.4% & the Australian Defence Health Status Report = 31.5%





## Discussion

- The trunk (ARES = 23.4%: ARA 21.2%) next highest
- This result differs from the findings in the Australian Defence Health Status report in 2000 which found the upper limbs to be the next most commonly reported body location of injury in the Australian Defence Force as a whole (21.7%), followed by the trunk (14.8%).



## Discussion

- Both groups had similar PT percentages
- Notably higher sporting injuries in ARA (ARES = 2.5%: ARA = 8.9%)
- Combat tasks (inc patrolling) and manual handling were other activities for which differences between the two populations existed. (ARES = 29.6%: ARA = 13.8%)



## Concluding remarks

- ARES personnel would benefit from combat task orientated conditioning (e.g. load carriage)
- Based on previous literature, this conditioning should preferably occur on a weekly basis (Orr et al., 2010; Knapick et al., 2012)
- While wearing actual combat loads in public would not be suitable, encouraging and facilitating participation in orienteering, rogaining and hiking clubs may provide a means of providing some load carriage relevant conditioning stimulus



## Concluding remarks

- Detailed literature in this area is lacking and an increased focus needs to be placed on the injury prevention, physical conditioning and assessment of ARES personnel if they are to be safely employed at a level commensurate with ARA personnel





## Acknowledgement

- The Defence Health Foundation



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## APPENDIX 3: INCIDENCE RATES PRESENTED AT AMMA CONFERENCE

Incidence rates of reported work health & safety incidents & injuries in part-time & full-time Australian Army personnel



Rod Pope<sup>1</sup>, Dylan MacDonald<sup>2</sup>, Rob Orr<sup>1</sup>  
<sup>1</sup>Tactical Research Unit, Bond University <sup>2</sup>Bond University



### Introduction

- Internationally, Reserve personnel a critical element of military forces
- Often comparable duties to full-time personnel
- Little known of comparative WHS incident & injury incidence rates
- Injuries have substantial implications for the individual, & for personnel availability, operational casualty rates, budgets & more
- In Australia, the Defence Health Status Report (2000) indicated a recorded injury rate per 100 FTE military personnel 3 times as high in Reservists as in FT personnel
- No other similar research found, at a Force or Service level, internationally.



### Introduction

- Key further issue: injury definition & threshold for reporting
- Injury prevention efforts much more successful if reporting threshold low:
  - Greater statistical power to detect emerging issues in a timely manner
  - Actions to address near misses, dangerous occurrences & minor injuries reduce likelihood of escalating to more serious injuries & deaths
  - Latter only possible if near misses, dangerous occurrences & minor injuries routinely reported, considered, acted upon



### Introduction

- Valuable to examine reporting rates as an indicator of surveillance system utility
- Other indicators of system utility (McKinnon *et al.* 2009):
  - efficient, routine & multi-purpose inputs
  - system outputs
  - achievements in timely detection & remediation of emerging injury problems
  - feedback loops
- Reporting rates inextricably linked to these latter indicators – those supplying & entering data will not do so reliably unless these indicators addressed (McKinnon *et al.* 2009)







## Aims

1. To investigate & compare the incidence rates of WHS incidents & injuries in ARES & ARA populations, reported in the WHSCAR database
2. To compare these *injury* incidence rates to injury rates reported by other injury surveillance systems for comparable army populations

*This research was supported by a grant from the Defence Health Foundation*



## Methods

- Retrospective cohort study, covering 2-yr period 01 Jul 2012 – 30 Jun 2014
- Ethics approval from ADHREC (LERP14-024) & BUHREC (RO1907)
- Abstract approved for presentation by JHC (150707)
- Incident data for ARES & ARA extracted from WHSCAR database by system administrators, & made non-identifiable before supply to research team
- Population sizes ascertained from annual *Defence Agency Resources & Planned Performance* reports
- Total annual numbers of ARES days served provided by AHQ



## Methods

- Incidence rates for WHS incidents & injuries reported by the ARES & ARA populations in the 2-year study period calculated:
  - *per capita*
  - *per FTE* (accounting for actual days served: assumed 1.0 FTE = 232 days)
- Incident rate ratios (IRR), ARES: ARA, calculated for reported WHS incidents & reported injuries, based on *per FTE* rates
- Finally, ARES & ARA *injury* incidence rates compared descriptively with incidence rates derived from other systems for similar populations



## Results

**ARES and ARA Population Sizes 2012-2014**

	ARES	ARA	Whole of Army
2012 - 2013	14867	28955	43822
2013 - 2014	15200	29847	45047
Mean pop. 2012-14	15034	29401	44435





## Results

ARES & ARA estimated person-years\* of active service 2012-2014

	ARES	ARA	Whole of Army
2012 - 2013	2296	28955	31251
2013 - 2014	2405	29847	32252
Total pers-yrs 2012-14	4701	58802	63503

\*One person-year of active service nominally estimated equivalent to 232 days of active service: 365d - 104d weekends (or 'in-lieu' non-service days) - 20d AL - 9d publichols



## Results

Incidence rates & IRR for reported WHS incidents, by Service type  
(WHS incidents per 100 soldiers per year [per 100 person-years of active service])

WHS incident type	ARES	ARA	IRR (ARES:ARA)
Minor personal injury	4.55 [29.10]	15.58 [15.58]	[1.87; 95% CI 1.78-1.96]
Exposure	0.29 [1.83]	5.17 [5.17]	[0.35; 95% CI 0.29-0.44]
Serious injury or illness	0.22 [1.40]	1.14 [1.14]	[1.24; 95% CI 0.96-1.59]
Dangerous occurrence	0.19 [1.23]	0.86 [0.86]	[1.43; 95% CI 1.09-1.87]
Near miss	0.04 [0.23]	0.15 [0.15]	[1.51; 95% CI 0.81-2.82]
Fatality	0.01 [0.04]	0.02 [0.02]	[2.78; 95% CI 0.60-12.9]
Total	5.29 [33.84]	22.91 [22.91]	[1.48; 95% CI 1.42-1.54]



## Results

Incidence rates & IRR for reported injuries, by year and Service type  
(Injuries per 100 soldiers per year [per 100 person-years of active service])

Years	ARES	ARA	IRR (ARES:ARA)
2012-2013 (1 year)	4.76 [30.84]	16.49 [16.49]	[1.85; 95% CI 1.72-2.00]
2013-2014 (1 year)	4.78 [30.19]	16.93 [16.93]	[1.80; 95% CI 1.67-1.93]
2012-2014 (2 years)	4.77 [30.50]	16.72 [16.72]	[1.82; 95% CI 1.74-1.91]



Comparisons of WHSCAR injury rates with injury incidence rates recorded by other injury surveillance systems, in similar populations





## Discussion

- The rates of reported incidents recorded in the Defence safety & compensation incident reporting system (WHSCAR) observed in this study of the period 2012-2014 were just slightly higher than the rates observed for FY 97/98 (Defence Health Status Report).
- The rates were much lower than rates recorded in available point-of-care injury surveillance systems
- It is impossible to tell whether observed differences between ARES & ARA in WHS incident & injury risks are real differences or simply differences between the populations in reporting thresholds & rates – the latter is likely.



## Discussion

- Point-of-care injury surveillance systems have consistently demonstrated much higher incident & injury reporting rates than safety & compensation reporting systems, where reporting is generally not directly tied to care.
- However, point-of-care systems do not readily detect some types of WHS incidents, such as dangerous occurrences & near misses.
- Higher WHS incident & injury reporting rates & lower reporting thresholds increase the volume of incident data & so increase statistical power to detect emerging problems early & prevent escalation to more serious incidents & injuries.



## Discussion

- There remains an opportunity to very substantially enhance WHS incident & injury surveillance & control in the military context using:
  - hybrid, integrated approaches which ensure injuries & near misses etc are detected
  - multi-purpose data collection & entry systems to gain efficiencies (McKinnon *et al.* 2009)
  - smart systems which monitor emerging trends in real time against established control parameters & push alerts to commanders when but only when appropriate
  - purpose-designed response mechanisms activated when problems are detected
  - feedback loops to key stakeholders & especially data providers & data collection/ entry staff (McKinnon *et al.* 2009)
  - command incentives for prioritisation (not for low rates! (van der Schaaf & Kanse 2004))



## Discussion

- Such developments would markedly reduce actual WHS incident & injury rates, thus increasing personnel readiness & availability, as multiple demonstrations have shown.
- Such changes would greatly benefit ARA, ARES & other ADF Services alike.







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## Acknowledgement

- The Defence Health Foundation



## Questions

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## APPENDIX 4: ARMY RESEARCH SCHEME EXPRESSION OF INTEREST

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### ARS EXPRESSION OF INTEREST FORM Instructions

- Limit response to space provided
- Funding limit is <\$80,000
- The EOI must identify which question(s) from the Army R&D Plan of the Future Land Warfare Report the research will address
- If ethics approval is likely, confirm that you have sought the advice of the Australian Defence Human Research Ethics Committee as its approval will be required in addition to that of your institution ([ADHREC@defence.gov.au](mailto:ADHREC@defence.gov.au))
- Send your EOI or questions to [Army.Research@defence.gov.au](mailto:Army.Research@defence.gov.au)



## ARS EXPRESSION OF INTEREST FORM

**Project Title:** Getting ARES, ARA Fit

**Project Lead:** Doctor Rob Orr

**Organisation:** Bond University

**Department:** Tactical Research Unit

**Funds Required:** \$51,776 (GST Exclusive)

**Time required:** 12 months

**Deliverable:** Article

**Contact Details:** Doctor Rob Orr, Tactical Research Unit, Bond Uni

### R&D Plan and/or FLWR Questions Addressed:

Army Modernisation Line of Effort: Human Performance: Enhancing Health and Wellbeing: What are the best physical conditioning regimens for human performance optimisation and injury prevention in the Army's workforce and what are standards and competency implications for individual trades

### Summary of Research and Methodology:

Building on the Australian Army Reserve injury profile developed through a Defence Health Foundation grant in 2015, two Phases of research will commence. Phase 1: To establish current ARES fitness levels: ARES fitness assessment data (Basic Fitness Assessment data and Physical Employment Standards – Army) will be sourced through 2nd Division units. In addition, data will be sourced from the Royal Military College – Australia to examine ARES officer cadet entry standards. Comparative ARA data will be captured via purposive sampling. Data will be analysed descriptively and inferentially (independent sample t-tests and Analysis of Variance). Phase 2:

### Benefit to Army:

Based on the Defence Health Status Report (2000) and this research teams findings following research undertaken in 2015 (Defence Health Foundation Grant), Army Reserve personnel sustain more injuries and incur more working days lost than regular army personnel. Knowledge generated from this program of research will inform measures to optimise the physical conditioning and resilience of army reserve personnel and enhance their health and wellbeing. The downstream effects of these measures will see a reduction in injury risk to reserve personnel, who are playing an increasing role in full time current and ongoing operations.